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ONE OF THE CHARACTERISTIC FEATURES *of living creatures is organization and pattern. This pattern often extends itself to the general appearance. The lacelike object in this picture might be mistaken for many things, such as the blood capillary system in the skin of a frog. In actual fact it is part of the surface of a sea fan. This creature belongs to the same class of invertebrates as the corals and sea anemones. They are attached to the bottom of the sea. Although plantlike in appearance, the small projections that may be noted in the meshes of the net are actually fine anemone like heads of individual creatures in the colony.*

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INTERNATIONAL

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FOUNDATION

Editorial Office: The Marine Laboratory, University of Miami, Coral Gables, Fla.

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Many Explorations

By F. G. Walton Smith

Those who work, play or travel by the sea are almost always curious about the creatures living within its waters, the leviathan whales and their smaller relatives, the porpoises, the fast swimming migratory fishes of deep waters or the reef corals, jewel headed worms, seashells, and crustaceans of the shallower zones. Even the landlubber has this curiosity. How else, for instance, would marine aquaria be so enormously popular? Yet, despite this widespread interest, it is remarkable how little is known in general of the precise nature of the activities of biologists who explore this fascinating realm. The average person, in fact, conceives of marine biology as an occupation which mainly involves expeditions for the collections of fishes and the smaller marine creatures in the hope of finding new and rare species; or of invading the seas with diving mask, oxygen lung or bathysphere in order to explore the less known and deeper waters for exciting new forms of life still to be found. Nothing could be more remote from the truth, for marine biology is a wide and challenging frontier of science with many doors waiting to be opened in as many fields of discovery.

What is Marine Biology?

The work of marine research institutions covers so broad a front and their scientific investigators are specialized in so many diverse ways that even the scientists themselves may not be fully aware of the activities of all of their fellows. Changing fashions in science, too, bring changing emphasis in research objectives and methods. There is a historical growth and development in all science and this is certainly true of the biological studies of marine life. Just what, then, are the problems that occupy the curiosity of a seagoing biologist, if they are not simply a matter of collecting strange creatures and naming them or of exploring with diving gear and camera?

Zero Line of Life

The Greek scientists, for the most part, were content to speculate from an arm chair viewpoint and marine biology was therefore a mixture of a minimum of fact with a maximum of highly imaginative speculation, legend and mythology. Aristotle, almost alone, soiled his hands with the work of direct observation, when he made a study of life in the Aegean Sea. In later centuries, the stimulus of Linnaeus, who first attempted a unified system of describing, classifying and naming living things, led to a great era of cataloguing in which the question, what kinds of life are there in the sea, was the prime consideration. Later, of course, as the hundreds of thousands of different kinds of sea

OWERING A DEEP-SEA DREDGE. *This is ne of the instruments used for collecting animals from the sea bottom. It as brought from deep waters many range creatures and has helped to add the growing list of known sea life.*

MARINE BIOLOGIST, *Joan Clancey, works on the identification and classification of marine life, in this case young fishes.*

life along the shore became better known, attention was turned to the deeper waters. It is not so many years ago, about the middle of the last century, that Edward Forbes was led to believe there was a lower limit, the "Zero line," at 1800 feet, below which there was no life in the sea. During the last 100 years this idea has been discarded and, with increasing exploration and collecting, sea life is now known down to the greatest depths, in over 35,000 feet.

Age of Expeditions

For about 80 years, until the second quarter of the present century, it was a golden age for collecting. Expeditions were numerous, covering the life of the sea bottom, the fishes and other swimming creatures, and the plants and animals of the shore. Museums played a great part in the adventure of making this giant inventory. Many university biology departments followed with their studies of the plankton, when Muller had drawn attention to the great importance of this drifting microscopic life of the sea.

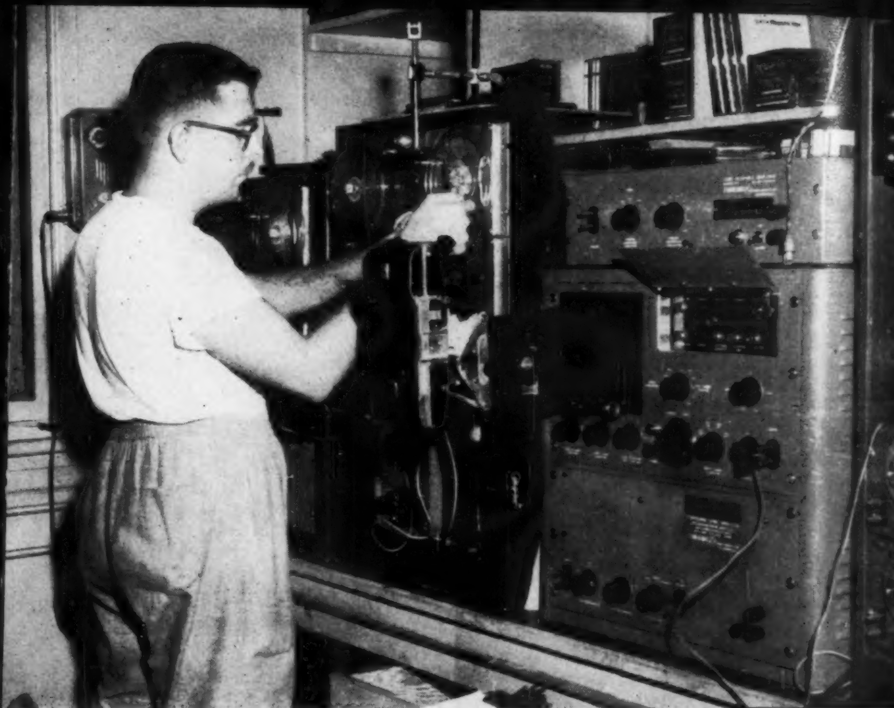
So far the question had been, what

is in the sea, and for the most part it was posed from the viewpoint of dry land biologists. The great wealth of new creatures which were brought to light in answering this question drew the interest of an increasing number of scientists for a wide variety of reasons. The development of the theory of evolution was both stimulated by and also contributed to a growth of interest in marine biology, since the origin of all life is in the sea. In fact, most of the actual story of the evolution of the animal world and a good deal of the plant world is to be found in sea life. The study of geology, the rocks which formed the ancient sea floors, depended heavily on knowing the sea fossils which are found in them, in order to date them. This long dead sea life could only be understood by reference to its living relatives. The very structure of living creatures on land is only to be properly interpreted in the light of the structures of their marine ancestors.

Why a Starfish Egg Becomes a Starfish

The part played by marine life in the study of biology as a whole was responsible for founding some of the well known marine biological stations. For many years and even today there are a great proportion of these stations which function mainly so that the inland biologist may spend his summer vacation or sabbatical year in the study of marine life as a part of his special interest in biology. This was good, for it provided the material that led to much of our present day knowledge of many branches of biology. Naples, the Woods Hole Marine Biological Laboratory and many others were organized to provide facilities for visiting investigators as much as resident scientists and these facilities paid off handsomely. The studies of the microscopic young stages of sea worms, starfishes and sea snails did much to elucidate the problems of development and evolution in animal life as a whole. Later, the artificial separation of individual

SETTING FISH TRAP *from Cuban research vessel* Yara. *This is another of the varied types of nets and gear used for collecting sea life.*



MARINE BIOLOGY, *originally mainly collecting, describing and naming, has grown to cover a wide range of experimental research. In this picture an expert on underwater sound carries out detailed analyses of the noises made by sea creatures.*

cells of the developing larvae, the centrifuging of the eggs, even cutting them in microscopic parts by amazingly delicate techniques, all helped to found our knowledge of the why of embryology, the intricate and beautiful system of chemical and physical patterns of organization of control which cause a starfish egg to become a starfish and a human egg to become a human being.

Biological Oceanography

Small wonder, in the light of the great part played by marine life in biology as a whole that marine laboratories became fashionable. But so far the interest was primarily that of biology with the seas as rather incidental sources of material for study. It was marine biology with the accent on biology. But another stimulus was to turn scientists closer to the ocean itself, to a study of the ocean from a biological point of view, with the ocean the central problem and biology, along with chemistry, physics, and geology as the rather incidental methods of attack. These new questions, the how and why of the oceans and their living contents are the substance of oceanography and the biological approach to this is better called biological *oceanography* to dis-

tinguish it from the different approach of oceanographic or marine *biology*.

The Sea Fisheries

The new stimulus came with the growth of fisheries and the increasing fear that the natural stocks of fish would be depleted. Particularly was this true in the North Sea countries where heavy populations made them dependent upon seafood. And so science began to think from the point of view of the sea itself and not that of the purely laboratory biological outlook. Marine laboratories of the Scandinavian countries, Germany, France and Great Britain, were founded for study from the oceanographic viewpoint. Many of the great names among the marine biologists of the last generation were really oceanographers in outlook and though many of them were led into this from an earlier purely biological interest, more and more of them began their research careers with the oceanographic outlook.

Although even today the oceanographic outlook is in the minority, there has been a continual growth in this direction. With the passing of the stage where the biological emphasis was on what creatures are in the sea, interest grew in the problem of distribution, why a certain fish only lived in certain parts of the sea, or why there are different kinds of barnacles or sea snails at different levels of the seashore between and below the tides, or why the creatures of a sandy shore would not grow on rocks. At first this study, ecology as it is known, was purely descriptive. It was enough to classify the different types of environment, according to the temperature of the water or whether the bottom is muddy, sandy, or rocky, and so forth. These different situations were classified in the most detailed and teutonic fashion and so were the creatures that inhabited them. As biological science during the last few decades became more and more experimental the study of ecology became more directed to trying to find out, not how creatures are distributed, but why, what is it about muddy bottoms or high temperature, saltness or strong currents, for instance, that favors the growth of some creatures and not others? Why do some fishes migrate one way and some another?

Important Applications

Today, there are widely different activities, all referred to generally as marine biology, although at the extremes some are almost purely biology and others almost purely oceanography. Some are concerned with the application of science to the commercial fisheries. What factors are operating to reduce the natural fish population, how do fluctuating sea currents and temperatures affect them, to what extent does fishing reduce them? Some are concerned with other applications of science to useful purposes, to the preservation of wooden docks against the damage of marine boring shipworms or the design of paints for preventing fouling on ships' bottoms. Even the lowly bacteria of the sea are involved in metallic corrosion.

But all of these applied problems, as well as the basic problems of biological oceanography involve a

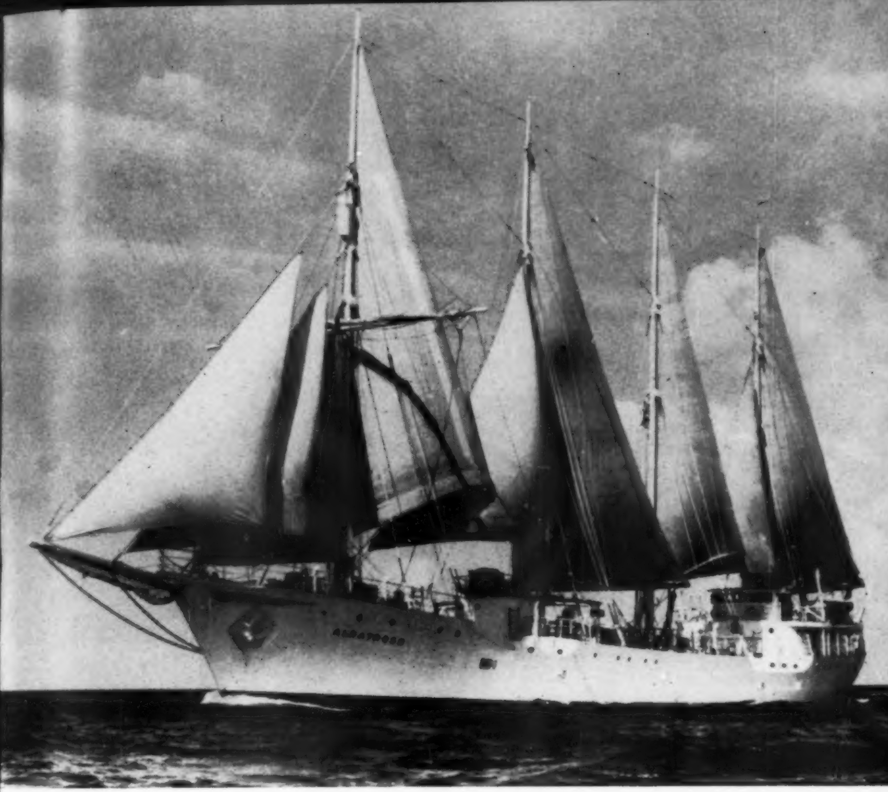
knowledge and understanding of the structure, behavior and inner workings of the creatures concerned and this is where the biologist, less interested in the sea than in the creature itself, still contributes largely, by bringing necessary information to the oceanographer to apply to his sea problems as well as to the equally vital problems of biology itself. The large sea squids are important items of the marine economy off the Pacific coast of South America and bulk largely in the food of swordfish and tunas. But they also possess a giant nerve fibre which is highly suitable to the experimental study of nerve function in general. Thus, a marine research laboratory today may still function as a facility both for investigating the ocean as to its life and also for investigating the basic problems of life in general. Probably the greatest individual stimulus comes where the laboratory brings together scientists interested in all these phases, pure and applied science, biological oceanography and biology for itself.

News and Information

The International Oceanographic Foundation in seeking to advance the study of the seas, seeks to bring to the general reader information on all these diverse phases of biological investigation as well as investigation into ocean currents, the sea floor and the other nonbiological problems of the sea.

In doing this it is important perhaps to realize that all forms of scientific attack have their own special value. Although systematics, the collecting and naming of sea creatures, is no longer almost the entire aim of marine biological laboratories, it is none the less important to the oceanographic biologist. The study of what has always been called marine biology is a wide one today and one in which the individual scientist finds it increasingly difficult to keep informed about the activities of all of his fellows with their diverse aims and techniques. We believe there is a place here for the Bulletin.

AT A MEETING *held in Sao Paulo, Brazil, last October, delegates from Latin American countries called into conference by the United Nations UNESCO discuss the future development of marine biology. In the photograph are Doctors Soriano (Uruguay), Besnard (Brazil), Nonato (Brazil), Sawayo (Brazil), Ribeiro (Brazil), Schweigger (Peru), Howell (Cuba), Smith (U.S.A.) and Wilhelm (Chile).*



THE FOUR-MASTED SCHOONER Albatross, *1,400 tons dead weight. She is not only one of the few training ships of her type but a practical cargo vessel and, for a time, a deep-sea oceanographic research ship.*

Deep Sea With The Albatross

THE FOUR-MASTED SCHOONER *Albatross* recently entered the port of New Orleans, carrying freight. The unexpected sight of this well-known Scandinavian training ship brought back to mind her past services to deep-sea oceanography, for one of the most interesting scientific investigations of recent years regarding the deep sea floor was made aboard her. She has followed a line of distinguished deep-sea research ships and is a great ship herself, a worthy symbol of the considerable services which small Scandinavian countries like Sweden and Denmark have rendered to oceanographic science.

VIEW OF THE DECK *of* Albatross. *She is 235 feet overall length with 37 feet beam. Although classed as a full-powered motor sloop, her construction, scantlings and rigging comply with Lloyd's requirements for sailing ships.*

How Deep?

The floor of the ocean is the most inaccessible part of the outer skin of the earth. It is easier, by far, to plant a flag on Mount Everest than to gather by hand a sample of the deep sea floor. It is difficult, expensive and time consuming even to reach the deepest bottom with cables and

instruments. The first really serious attempt to study the deeper layers of the ocean took place towards the end of the eighteenth century, when Captain Phipps, later Lord Mulgrave, took what was then a record sounding of 4,000 feet in the Arctic and brought up samples of blue mud. Yet the deepest part of the ocean extends far below this early record, down to well over 30,000 feet. Some years later, Sir James Clark Ross, during the British Antarctic Expedition, reached 15,000 feet in the southeast Atlantic. He was still only halfway to the deepest sea floor.

Cable Soundings

With the laying of submarine cables the need for ocean soundings became a practical matter and more effort was given to deep ocean research. The original clumsy rope line was replaced by a thin metal wire and sounding gear in general was improved. Finally the *Challenger* Expedition spent three and a half years in the three major oceans studying the sea floor and the life of the deep salt waters, to such good purpose that the results were later published in over 40 large volumes. Following this classical voyage, Prince Albert of Monaco, Alexander Agassiz, Carl Chun and others led noteworthy expeditions during the latter part of the century.

During the twentieth century great advances have been made. Not only have sonic echometers greatly simplified depth measurements but methods of sampling have been improved. New techniques were developed in shallow waters as a result of the research fostered by the International Council for Sea Investigations representing the North Sea countries. These were first applied to the deeper oceans by Sir John Murray and Johan Hjort in the *Michael Sars* expedition and by scientists on the German *Meteor*. These expeditions were still not able to sample more than a thin skin of the ocean floor, but it was not long before even better methods were discovered.

Age of the Sea Floor

Sea floor samples are taken by means of a corer. This is essentially a tube, driven into the sea bottom so as to retain and bring back to the surface a rod-like section or core of the bottom. Because of the slow accumulation of sediments on the ocean floor, a three foot core might contain materials which have taken over 100,000 years of time to accumulate. The undisturbed core, when examined, could thus reveal something of the past history of the bottom over a long period of time. For instance, the shells of tiny creatures, the foraminifera, contribute largely to certain sediments. Since different kinds of foraminifera grow best at different temperatures, the change in types of shell at different levels of a core give tell-tale evidence of ancient changes in the sea climate.

Setting a Record

A record core length was set by Dr. Piggot, who invented an explosive core-sampler, whereby the tube was forcibly driven into the seafloor. During the 1930's he obtained a ten foot core in the northwest Atlantic. There

BOTH ENGINEER *and deck officer apprentices get their preliminary training aboard* Albatross, *with classwork as well as practical experience.*

still remained a problem, since the core, forcibly driven into the tube, was apt to be distorted and so lose some of its chronological value. The next big advance in coring devices was made as a result of the interest of Swedish oceanographers at the Oceanographic Institute of Göteberg and the individual inventiveness of Börje Kullenberg and Hans Pettersson. Kullenberg developed the piston core sampler, which is designed to overcome friction between the walls of the tube and the core being forced into it. By means of a piston, automatically withdrawn as the corer penetrates, undisturbed cores as long as 65 feet were obtained. These could well represent an accumulation of sediment over a period of three million years.

Thickness of the Sea Floor

Other deep sea problems concern the origin and nature of the rock layers beneath the sediments and the types of volcanic or igneous rock involved, in fact the very basic formation of the ocean itself. For this purpose explosive charges may be set off under water. Instead of the explosion giving a single echo reflected from the sea floor, several successive echoes may be received by the ship, each in turn coming from a deeper layer of harder rock. The time delay between echoes gives an indication of the thickness of each of these layers.

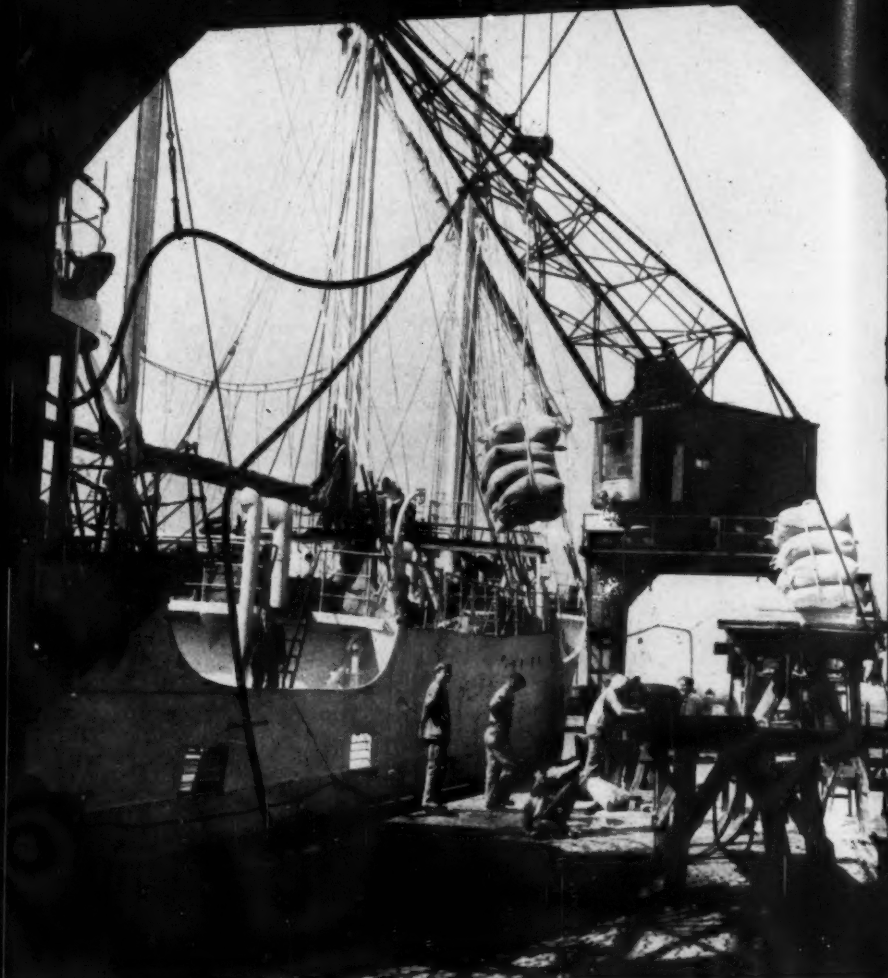
Scientists of the Swedish Oceanographic Institution, after a preliminary test of their new methods and techniques in the Mediterranean, decided to put them to work in the

deep oceans. For this purpose it was necessary to find a large enough ship with a sufficiently powerful winch and long steel cables to handle the heavy coring tubes at great depths. The problem was overcome by the loan of the 1,450 ton motor schooner *Albatross,* the new training ship of the well-known Broström shipping syndicate. The winch itself was specially designed and built for its purpose. Leading industrial firms in Sweden also helped by manufacturing special gear and the Royal Society of Göteburg gave financial support. Technical advice, information and special instruments came from the British Admiralty, the U. S. Hydrographic Office and the Woods Hole Oceanographic Institution.

The ALBATROSS

Albatross is a four-masted fore-and-aft steel schooner built to the highest class of Lloyd's Register, to an overall length of 235 feet and a 37 foot beam. Her sail area is close to 10,000 square feet and her tonnage, dead weight, is 1420. For auxiliary power she has an 8 cylinder Eriksberg diesel engine developing 450 horsepower. Although classed as a fullpowered motorsloop, her construction, equipment, scantlings and

THE ENGINE ROOM *is especially well equipped for indoctrinating engineer apprentices.*



ALTHOUGH USED *both as a training ship and for oceanographic research,* Albatross *is a practical cargo vessel. Here she is shown loading.*

rigging comply with Lloyd's requirements for sailing ships. *Albatross,* though serving admirably the purpose of a deep-sea research vessel, was originally designed as a training ship. In many ways she is unique, besides being one of the few remaining training ships run by a private shipping enterprise and so almost a lone survivor of a great tradition. Her design, rigging and general planning represent the latest views of modern economic cargo ship design at the

time she was built in 1941 at Lindholmens Varv.

Although launched in 1942, the second world war delayed her entrance into active operation until 1945. She then began three round voyages between South Africa and South America. The Broström combine, for which she was built, is probably best known for its leading member company, the Swedish American Line, with over 20 fine cargo ships and the luxury liners, *Kungsholm*, *Stockholm* and *Gripsholm*.

Unique Training Program

With the other members of the combine, Swedish-American set up an unusual training program for *Albatross*. The idea was to give apprentices an all-round preliminary training, with no differentiation between navigating and engine room officers. Her engine room is therefore especially well equipped. Her navigational equipment is also extensive and modern. After leaving *Albatross*, the students join Broström cargo liners as navigating or engine room apprentices, where they are able to progress far more rapidly as a result of the time spent aboard the training ship.

It was in 1947 that *Albatross* was outfitted for the deep-sea expedition and she began this fifteen month, round the world voyage in July of that year. The scientific staff of ten was headed by Pettersson and included Kullenberg, who handled the coring operations and Weibull, who had previously developed the explosive techniques for investigating the deep layers of the ocean bottom. In addition to the sea floor studies, biological samples were taken with deep-sea hauls and dredges, during the last three months of the cruise, in the North Atlantic Ocean. The sediment carpet of the bottom, previously almost unknown below a thickness of three feet, was the great purpose and all effort was concentrated upon this.

Oceanography is International

What is not generally realized is that the work of an expedition is not even a quarter finished by the time it returns to home port. The collection of data or specimens, is, by itself, valueless, although, unfortunately, from time to time, an occasional expedition still goes out, privately sponsored, but in the name of science, with little or no definite objective beyond such collecting. But the Swedish Deep-Sea Expedition had well defined objectives for the study of the sea floor, and the collection of cores, soundings and echo measurements was merely the beginning. The examination of specimens and the calculation of data from such an expedition often take more than ten times the amount of time that the expedition itself does.

Cooperative Research

Fortunately many organizations lent a hand, so that a good part of the scientific observations could be worked up and their significance determined. Here was an excellent example of the international spirit of scientific research, and particularly of oceanography. The expedition was accompanied from Martinique to Cristobal by Fred Phleger, the outstanding authority on foraminifera,

from the Scripps Institute of Oceanography, in California, who also studied and reported on some of the cores collected. Financial assistance came from the Geological Society of America and from the National Research Council of Sweden. Chemical analyses were carried out at the Olof Arrhenius Laboratory in Sweden and by Rotschi and Berrit in France.

The results of such an expedition, in fact the whole fascinating problem of the origin of the ocean basins, the nature of the volcanic material which frame them and of the sediments which have covered them for millions of years, are beyond the scope of a single article. The question of how and when the basins were first formed, whence came the water itself—from the condensation of primeval clouds surrounding a hot and juvenile earth or from the rocks themselves, such vital and fascinating problems will form the subject of future articles. For the present it is possible only to report that the *Albatross* expedition, in places where a few three-foot cores were the limit of previous knowledge, was able to push the extent of knowledge twenty times as far. Indications were that the sediment floor of the Atlantic Ocean in places extended to over 10,000 feet, the equivalent of 500 million years, about a quarter of the entire probable life of the earth.

For the Future

Experience gained by the Swedish *Albatross* Deep-Sea Expedition, according to Pettersson, has shown that an ideal ship for this type of deep-sea floor study would be between 1200 and 1500 tons dead weight, with a cruising range of at least 8,000 miles and speed of 12 knots, she would have a winch powerful enough to raise a weight of 1-½ tons at a speed of 3 to 4 feet per second and have appropriate accommodations and work space for about 12 scientists.

Since all of this adds up to a building cost of over 2 million dollars the ideal deep-sea expedition is beyond the scope of most private research organizations. In addition, the scientific results of an expedition that has been at sea for the greater part of a year may require, for the final working up and evaluation, several years of effort on the part of a team of specialists, which is probably beyond the resources of any one research institution. There can be no stronger argument for institutional and international cooperation in this type of research.

FOR FURTHER READING:

Westward Ho with the ALBATROSS, by Hans Pettersson, 1954. This is a lively personal narrative of the Swedish Deep-Sea Expedition covering 4,000 nautical miles in three oceans, beginning 1947. Should be of interest to the scientist or general reader.

The Ocean Floor, by Hans Pettersson, 1954. A more technical account of deep-sea research, including that of the *Albatross.*

THE MARINE STATION *at Bears Bluff, S.C., was founded in 1946. It has since developed into a village of guest cottages, workshops and the main laboratory building.*

Mosquito Fleet

By FRANCIS B. TAYLOR

MARINE FISHERIES in South Carolina have "just growed", like Topsy. There has been commercial fishing right along in the ocean waters and the myriad salt creeks and sounds bathing Lowcountry marshes. It could not, however, be described accurately as an industry. Rather, it was scattered individual effort. Until recently, the burden of the catch came ashore in Charleston's fabled "mosquito fleet" of crazily rigged craft and their Georgetown and Beaufort counterparts.

The commerce involved in the catch was summed up mostly in the ebony-faced hucksters who hawked their wares through the streets. Their hoarse cries of "Shrimp!" and "Crab-crab-crab!" or "Whitin!" and "She-crab!" brought turbaned cooks to the street ready to haggle and to chat; with, perhaps, the mistress, her purse in hand, to supervise from the piazza. Little of this catch ever got out of town. What fish the hinterlanders ate came from their own fresh water streams or salted from New England. The big change is that frozen fish are sold widely nowadays.

Growth of a Fishery

In the old days, if shrimp were scarce or the crab failed to appear or the whiting didn't bite, the matter got little attention. Nobody but the fishermen wondered at their luck. Until about 1950, when the Legislature began to appropriate funds for Bears Bluff Marine Laboratories on Wadmalow Island, no more than $1,000

of State funds ever had been recorded as spent on investigation of the fisheries.

In two decades, South Carolina's marine fishery has changed consider-

ONE OF CHARLESTON'S *fabled Mosquito Fleet. Boats such as this formerly supplied the Low Country South Carolina markets with sea bass and other fishes taken along the ten fathom curve.*

ably. Growth of shrimping since the mid-1930's has stirred an industry to life. The mosquito fleet and the cast net in the creek could not supply the new demand. The call for shrimp from afar off could be answered only with modern boats and equipment. Nearly 400 trawler boats are licensed this year.

The postwar years have brought further quickening of interest in crab and oysters, too. Yet there is nothing like full utilization of the resources, especially in the fin fish department. In fact, this has fallen backward if statistics are reliable. The latest figures available, the United States Fish and Wildlife Service's catch report for 1952, indicate South Carolina's fin fish catch was down 26.1 per cent from 1951. In Charleston, the huckster's cry is all but stilled. The mosquito fleet molders on the beach; menhaden boats land their catches in South Carolina only spasmodically and the haul seines dip but little food fish from the surf along Horry County's Grand Strand. Wholesalers get only about one-sixth of their requirements from local fishermen.

This is far from saying that there are no fish in the sea off South Carolina. It is to say that little has been known about commercial possibilities, because few have looked deeply into the matter.

Need for Research

The lack of scientific work in South Carolina waters is reflected by gaps in statistical knowledge of habits and movements of croaker, spot, the trouts, whitings, etc. near shore; or the big fellows in the deeps. Bears Bluff is about to change this. Although it was founded in 1946 primarily as an oyster research station by the benefaction of the late H. Jermain Slocum, Bears Bluff has expanded its activities to embrace the field of marine fisheries important to South Carolina. Much of this has been made possible by the interest of former State Senator George Warren of Hampton who is chairman of the State Wildlife Resources Commission.

A two-year survey of shrimp trawling has yielded data still being digested and interpreted. A newly-acquired and larger vessel permits pursuit of the elusive brown shrimp to his ocean lair; the probing for winter whereabouts of the white shrimp and the brown-spotted shrimp, *Penaeus duorarum,* as the biologist calls it. These fall and winter cruises will keep a lookout for passage of pelagic fishes; whilst a slender staff ashore studies the fatally fecund oyster; the habits of the crabs and the growth and mortality of marine life in the station's marsh creek impoundments.

A New Fishery

In its nine years of life, Bears Bluff has begun to prove its worth to a budding industry. Proponents and opponents of winter crab trawling in the sounds of the State turned to the laboratory for advice. Based on information and belief, a trial run was suggested. Shrewd guessing, biological intuition or whatever, scientific opinion that it would not damage the blue crab's future has been borne out in a vindication of its own data's accuracy.

After 4 years of winter trawling for crabs while shrimp trawling is banned, Bears Bluff's estimate that this summer's trotline catch would be up about 11 per cent has been verified by the Beaufort representative of the Fish and Wildlife Service. He reports 10 per cent increase at least and possibly an all-time record high crab catch in South Carolina waters. Likewise, autumn trawling in Beaufort County sounds, a recent innovation, was permitted in part on the strength of Bears Bluff recommendations.

Fishery Management

G. Robert Lunz, Bears Bluff director, believes that under-utilization of the State's fishery resources could be even more a waste than overfishing. How to strike a balance between the biological factors and the economics of fishing pressure, he thinks, calls for uninterrupted research of local conditions and enforcement of enlightened laws. South Carolina's marine fishery laws have developed piecemeal—just as the industry has "growed"—usually to meet a problem of the moment. Once on the books they usually have stayed. Often their writing was based on notions of conservation not usually founded in scientific knowledge.

The interests of the fishermen and enforcement of these laws have clashed often. The interests of the commercial fishermen and the sports angler also frequently clash. There is no bloodshed of record, but ill-feeling aplenty. There is a good chance that these laws will be brought up to date with modern knowledge. When they are—and a legislative committee is studying revision now—Bears Bluff will have a lot to do with it.

Bears Bluff research keeps a practical slant. How can its findings be of immediate benefit to South Carolina fisheries? The director believes his little staff and slender budget (smallest of any state on the Atlantic or Gulf coasts) must apply its research to the bread-and-butter matters of developing the industry.

MOSQUITO FLEET *landing its catch.*

THE SAILFISH *can always be relied upon to provide a spectacular fight.*

Gold Coast or Sailfish Frontier

IT IS UNFORTUNATE that the southeastern border of the Florida Peninsula was once labelled the Gold Coast and that the name has endured. Unfortunate, because it gives undue prominence to the lavish hotels, night clubs and private residences that crowd behind the more populous of the beaches, and gives no hint of the more natural and superlative qualities of this unusual stretch of seacoast which appeal equally to sportsman and scientist.

Gulf Stream Climate

The Florida Current, root of the Gulf Stream, here swings almost to within hailing distance of the shore and helps to soften the winters and cool the summers. In so doing it creates a nearly perfect climate for man. But it also provides for the sea water itself a climate exactly suited to some of the most colorful and exciting marine life in the world. The coral reefs of the southern tip of Florida with their spectacular

beauty and their brilliantly colored fish and invertebrate inhabitants are great places for fishing and for the sport of skin diving. They are also alive with situations and problems of interest and importance to science. The larger fishes, ranging wider afield, are more easily seen and known, and these claim a great and evergrowing army of devoted anglers. At the top of the list, and the most striking of all the sea has to offer here, is the sailfish, a beautiful and exciting catch even to the most experienced angler and a challenge, too, to the enquiring marine biologist.

SPORT *is combined with scientific research. After tagging, this sailfish is released to fight another day.*

The fly fisherman with ultra-light tackle or the angler who pits his heavy gear against the swordfish weighing over 1,000 pounds may scoff at sailfishing, but the truth remains that probably no other fish in the sea, except the white marlin, can offer such an acrobatic and spectacular display when hooked. Not only is he a terrific fighter but his great sail-like fin and streamlined silver and blue body qualify him for recognition in the marine *concours d'élégance.*

And to a smaller group of admirers he is esteemed because of the opportunities afforded in Florida waters, by virtue of his numbers, for the scientific study of one of a group of fishes hitherto not too well known biologically.

Five Kinds of Sailfish

South Florida has rapidly become a world center for research on saltwater gamefish, and the presence of sailfish and the active interest of sailfishermen must be given much of the credit for stimulating this. Florida has no monoply on sailfishes. They are likely to be found in almost all the tropical and subtropical seas of the world. The biologists engaged in their investigations at the American Museum of Natural History and at The Marine Laboratory of the University of Miami, fairly well agree that there are actually, in all probability, five different species. One lives in the Indian Ocean and the Red Sea, one in Japan and Hawaii, possibly another in Tahiti, and still another occurs along the Pacific coast of America from Peru to lower California. Finally there is the Atlantic sailfish which has been found, at times, as far north as Massachusetts and even, on one occasion, in the mouth of the River Yealm in England, conveniently close to the well known Marine Laboratory at Plymouth. The same species, apparently, is found in the Mediterranean, and as far south as Brazil.

Usually, though, the Atlantic sailfish prefers warmer waters. In the winter especially he is most likely to be found in the Caribbean, or off the coast of Florida. In spite of this wide distribution of the various sailfishes there is probably no place in the world where he is more heavily fished than in Florida. From Stuart south to the Palm Beach area is, in truth, the sailfish frontier, although they are caught to a lesser extent both south and north of this.

Huge Numbers

In one year, in the vicinity of Palm Beach alone, more than 2,500 of these magnificent fish were caught. Many of those hooked were around seven feet long. Herman Teetor's record for Atlantic sailfish is about ten and a half feet. The Pacific species record is about 11 feet with a weight of 221 pounds, caught by C. W. Stewart off the Galapagos Islands.

The sailfishing activity in the Palm Beach area is almost incredible. Contrary to past belief, sailfish do not migrate great distances *en masse,* so that fishing may continue at varying pace throughout the year. During the winter season the angling pressure reaches its maximum. The Sailfish Derby, in one year, listed 1579 caught by 40 boats. In certain years the International Light Tackle Tournament is held in this area, alternating with the Pacific Coast. Women have been nearly as active as men in sailfish angling. During the winter of 1955-56, the newly formed International Women's Angling Association also held a two-day competition. Mrs. Edwin B. Cosgrove released 6 fishes to win this competition out of a field of 66 lady anglers. Mrs. George Bass has two records, a 59½ pound fish taken on a 6-thread line

and a 69½ pound fish taken on a 9-thread line.

A Boost For Conservation

One of the things which takes this Florida sport out of the general run of big game fishing is the great interest shown in the conservation of the sailfish and in scientific research. These interests have been to a great extent fostered by the Sailfish Yacht and Beach Club, the West Palm Beach Fishing Club and the Sailfish Conservation Club. In order to minimize the danger of reducing the sailfish population by overfishing, the angler has been encouraged to release his catch as soon as it comes to boat. The white pennant traditionally lashed to the outrigger on the fishing boat for each fish boated is replaced by a red pennant for each fish released. As a further incentive, an engraved cigarette lighter is given to each person who releases a fish and the Sailfish Derby gives competition points for each fish released. In 1955 for instance, the highest individual total of released catches in the Derby was 35, a score run up by Lord David Crichton-Stuart, of the Isle of Bute, Scotland. During the 1956 Derby, 626 fish were caught in twenty-eight days.

PETER A. B. WIDENER III *and his wife, Louise, with the 1955 winner of the Widener Trophy. Mr. Edwin S. Rearick of Gary, Indiana, caught the heaviest sailfish—80 pounds.*

507 of these were released, an 82% score.

Further impetus to the sporting gesture of releasing the fish to live and fight another day is the award of buttons. The fish is measured by length, so that it may be returned to the water alive, instead of being brought ashore for weighing. A gold button is given for a fish over 8 feet in length. The fact that in one year over one hundred of these were awarded gives some idea of the terrific fishing that abounds here. Over twenty diamond buttons have also been awarded to those who have caught three fishes of this size. Recently Mrs. George A. Bass, Mrs. M. C. Smythe and Mrs. P. A. B. Widener III, were added to the list of lady anglers who qualified.

Science and Gamefish

Arising from the sailfish release program, interest has naturally turned to other conservation problems, to the habits of these fishes, to their migration, food and breeding habits. And so there has been a great stimulus to scientific research into all of these matters, with its value far beyond the original interests of angling. When the eight foot fish leaps out of water more than its own height and walks on its tail in a skittering dash of as much as thirty feet, there is the

ERNEST HEMINGWAY *autographs copy of his book* The Old Man and the Sea *for presentation with book end trophy in background, awarded in the 1956 Silver Sailfish Derby. With him is Johnny Rybovitch, who has been perhaps the greatest influence in the conservation of these fishes.*

MRS. E. H. GULBENKIAN *(left) of Larchmont, New York, and Mrs. Gustave Schirmer, of Greenwich, Connecticut, examine reel. Mrs. Schirmer released 21 sailfish for the Henry Chanin Trophy for lady releasing most sails—Sailfish Derby, 1956. Mrs. Gulbenkian was second.*

peak of angling excitement. But there is another kind of excitement that comes from tracking down the hidden facts of the life history of these fishes.

Much has been said about the feeding habits of the sailfish and some of the information comes directly from the anglers and the method of fishing. The fishing boats are fast and maneuverable, with long bamboo or tubular metal outriggers extending obliquely upwards from each side. At the end of the outrigger the fishing line is held loosely by a clip, from which it can be pulled by the jerk of a fish striking. The bait is towed from the outrigger in this manner 100 feet or so astern. In this way it is made to skip in a lifelike manner over the water. The bait used is either whole mullet or balao or else strip bait cut from the underside of a bonita. The fish strikes at the bait, which causes the line to be released from the outrigger. The bait itself, like a dead fish, remains still in the water as the slack of the line is taken up.

How a Sailfish Feeds

The technique of angling is based upon the actual feeding habits of the sailfish, but there are two schools of thought on this. One says that the fish strikes the bait with its bill in order to kill it. The other believes that the fish crushes the bait in its jaws and that the movement of the bill is purely incidental. Gilbert Voss, in charge of the ichthyological research at The Marine Laboratory at the University of Miami, has a unique advantage over most of his fellows because he was formerly a fishing guide and boat captain himself. According to him there is something to be said for both sides, but there are very few good observations on *natural* feeding as opposed to bait fishing.

Apparently, the sailfish rises behind the bait and, after looking it over, raises the bill in order to crush the bait in its mouth. Sometimes it may attempt to stun the bait with the bill. An examination of hundreds of baits struck at by sailfish, however, is very significant because it shows that in nearly all cases *both* sides of the bait have marks of the jaws and scales missing, not on one side as would be the case if struck by the bill alone.

Concentrated Food

The sailfish move in a predictable manner in relation to winds and tides and are also greatly influenced by the presence of food. They sometimes concentrate in great schools in order to feed on small clupeid-like fishes, locally misnamed "pilchards". The sailfish circle around their food with sails half raised, so as to concentrate the pilchards into a mass or ball of fish. At short intervals a sailfish swims slowly through the mass, thrashing vigorously sideways with its bill so as to kill or stun considerable numbers. It then turns and swims slowly downward beneath the pilchards and picks up the dead as they sink. During these sorties the fishing boats crowd around and the hooked sailfish become so excited that they have even been known to leap into a passing boat.

The enthusiastic anglers who joined forces to encourage the release of sailfishes were also the ones to support with equal enthusiasm a program of scientific investigation of these fishes. The Marine Laboratory at the University of Miami has set up a program for tagging sailfishes in order to determine their migrations and also the rate at which they grow. Several types of tags have been used. There are difficult problems involved in selecting a suitable tag. First of all it must be easy to put in place, in order that the fish may be released as quickly as possible. Secondly the tag must remain securely attached over a lengthy period of time and thirdly it must not harm the fish or interfere with its movements. Also there must be some way of identifying each tag by number.

Tagging Sailfish

The tag first used, the cattle tag, is a metal clip which is clamped by means of pliers over the edge of the gill cover or fin. This has proved successful. In fact the first tagged sailfish ever to be recaptured was marked with this tag. It does not appear to harm the fish. Another type of tag

TOMMY SHEVLIN, *former world record holder for a blue marlin of 636 lbs., tags sailfish with ring type tag, with Mrs. Shevlin's assistance.*

used experimentally was made of a neoprene rubber ring which could be slipped over the tip of the bill. This appears to damage the bill, and is being discontinued. Finally the dart tag is now being tried. The dart is a metal point with an attached label inside a small transparent plastic tube. The dart, held loosely on the end of a wooden pole, is thrust into the fish where it remains when the pole is pulled back. The label streams from the dart and does not hamper the swimming movements of the fish. Although it is too early to tell for sure, it is believed that the dart may slip out of the muscles of the fish or cause a sore spot.

In addition to tagging, the group of scientists working at Miami studied the feeding habits of the sailfish, with surprising results. Winfield Brady and H. P. Mefford examined over 240 stomachs of sailfish and found that the mullet, although used for bait, was poorly represented in the food. Flying fish, popularly thought to be a favorite food, were also present in unexpected small numbers. The false albacore was more plentiful, which explains why sailfish may

often be caught with live bait on the reef in deep water. Among the food was found a high percentage of octopods and squid, mostly the paper nautilus. These and even more so the remains of sea snails and sea robins, which live at the reef bottom show that sailfishes may be bottom feeders at times.

Taking the Food at Hand

The sailfish appears from this investigation to feed upon a variety of food, depending on what is available. The balao, used for bait, is a surface fish and is frequently found in the stomachs. At times nothing but anchovies, at others mainly needlefish will be present. All of this is of interest to anglers, but it also helps the marine biologist to build up a picture of the complex inter-relation of life in the sea and the causes of movements and migrations.

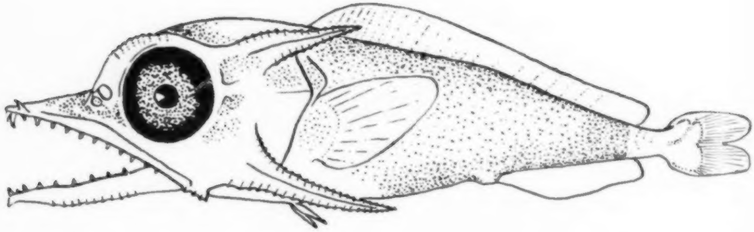
The tagging of sailfish has only been possible as the result of the co-operation of many anglers and boat captains. The Whiticar family at Stuart have been especially helpful and Captain G. C. Whiticar was the first man on record to have a fish tagged by him recaptured. Incidentally, the results of tagging and other observations show that there is no great migration of the fish and that many stay in Florida all summer. But the limits become extended and the northern schools of sailfish spread out to the north during the warmer weather.

Twenty-five Thousand Specimens

The extensive studies of fish life histories at Miami, listing over 25,000 new-born and juvenile specimens from one eighth of an inch long upward, include not only sailfish but hundreds of other ocean fishes. The baby sailfish was found to eat mostly copepods, tiny crustaceans in the plankton. One of them, less than an inch long, had inside it a fish known as a gonostomid. This was almost its own size, so that it had to be folded over three times to fit into the stomach.

Johnny Rybovitch, famed for his very successful fishing boat designs, Landsdell Anderson of The Sailfish Conservation Club and anglers like Pete Widener, Al Fleitas and Charlie Johnson have contributed much to the conservation minded sailfishing of the Palm Beaches, just as the Whiticars have at Stuart and the excellent boat captains in the Florida Keys.

THE CATTLE EAR TAG *used for tagging sailfish, shown attached to the fin of the fish.*



ENCOURAGED *by the support of anglers, scientists study the sailfish. Here is one of many small sails examined, utterly unlike the adult, with huge eyes and one-third of an inch long.*

Members of the Miami and Miami Beach angling clubs have also put their weight behind it. Attention is now spreading to research and at present the investigations at Miami cover not only sailfish but also marlin, bluefin tuna, bluefish, tarpon, pompano, weakfish and snook. The *Gold Coast* as a name for the east coast of Florida may well be replaced by the *Sailfish Frontier* and even perhaps by *Headquarters, Tropical Gamefish Research.*

Science of the Sea in Books

ARRANGEMENTS are being negotiated whereby current and new books dealing with scientific exploration and discovery and the natural history of the sea may be purchased by members through the Foundation at a saving in cost.

Reviews and References

New books will be reviewed as they are published. The reviews and purchasing privileges will, it is hoped, be applied not only to books for the more general reader but also to the more important scientific publications on marine subjects.

For the benefit of our readers, articles in future issues will also, where possible, be accompanied by book references for further reading, whereby those who wish may be able to

follow up subjects of particular interest to them.

Recent Books on Marine Science

A list is given below of some of the more interesting publications of recent years, suitable for the general reader. It is by no means exhaustive and, in this issue of the *Bulletin*, is mainly concerned with the science of the sea in general. Book lists in future issues will, however, cover such varied subjects as, for instance, deep-sea exploration, the deep ocean basins, skin diving and photography, the sea fisheries, game fishes, shell collecting, shore life, storm prediction and weather, ocean currents, waves and tides.

Publications in other Languages

Many of the more popular books listed are published in several different languages. The Foundation will be glad to give information regarding these, on request. From time to time new publications in languages other than English will also be reviewed.

Marine Science in General

THE SEA AROUND US
RACHEL CARSON. Oxford University Press, 1951. The success of this book speaks for itself.

THE OCEAN RIVER
HENRY CHAPIN AND F. G. WALTON SMITH. Chas. Scribners Sons, 1952. An account of the Gulf Stream, the ocean basin in which it runs, and the life in the sea and its effects on the Atlantic peoples. Illustrated.

THIS GREAT AND WIDE SEA
R. E. COKER. Univ. of North Carolina, 1947. A good compendium of marine science in general. For the student. Not too technical for the more serious general reader.

THE SEA AND ITS MYSTERIES
JOHN S. COLMAN. Bell, London, 1950. A general account of the oceans, their currents and the life within.

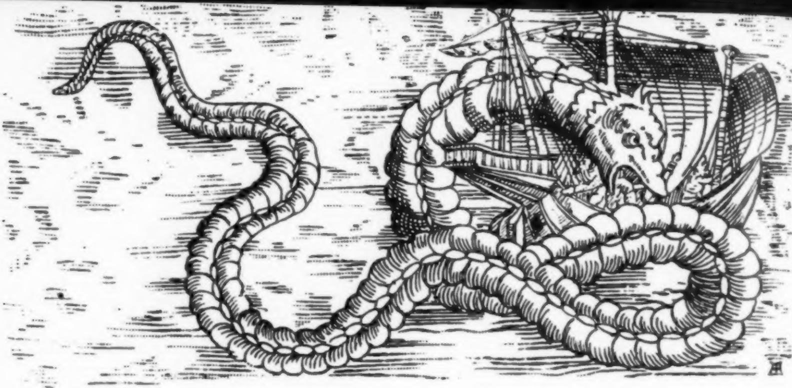
THE STORY OF THE OCEANS
JOHN SCOTT DOUGLAS. Dodd Mead, 1952. About the oceans, the sea floor, the ocean currents and sea life in general. Not illustrated.

THE MYSTERIOUS SEA
FERDINAND C. LANE. Doubleday & Co., Garden City, N. Y. 1947. The sea, its creatures, its resources, ships and trade.

THE OCEANS
F. D. OMMANEY. Oxford University Press, 1949. A well written account of the ocean and its life for the general reader.

LA MER
V. ROMANOVSKY, et al. Library La Rousse. 1953. An excellent encyclopaedic volume on the sea. Written in French but unusually well illustrated, with 870 figures and color plates.

THE SEAS
F. S. RUSSELL AND C. M. YONGE. Frederick Warne. Reissued 1947. Not a recent publication but still the best elementary general account of marine biology in non scientific language. Illustrated.



An old engraving *illustrates the fantastic stories woven by our ancestors about marine monsters. The sea serpent of Norway shown here has been described many times. Even today sea serpents turn up occasionally in reports.*

Marine Monsters

By F. G. Walton Smith

Human beings have always been fascinated by monsters. The abnormal, gigantic or hideous creatures of the land, whether real or merely products of a fertile imagination, have never failed to stimulate curiosity. The fabled giants, unicorns and dragons, the wild beasts of the jungle and pictured forms of huge prehistoric reptiles have equal power to draw attention. But it is in the ocean that the greatest interest lives, in the myths and monsters of the deep.

Unknown Frontier

This is easy enough to understand. The march of exploration and civilization on land has brought about the banishment of fictitious dragons and unicorns and has made lions, tigers, elephants and the rhinoceros almost commonplace. Greek and Roman mythology and the medieval superstitions are accepted only for what they are. But a new sea serpent incident, an unknown monster washed ashore, or the discovery of the comparatively slight monstrosity of a coelacanth fish, such monsters of the sea never fail to bring attention. The oceans are still the vast unknown part of the earth, deeper than the mountains are high and greater in extent than the land. Above all, since they are mostly unexplored by man, they are a naturally mysterious element, a potential home for monsters.

Our ancestors in their travels saw many strange things. In earlier days, lacking transportation, few people travelled far, and those who were able to do so were sure to report wonders from abroad when they returned, wonders which perhaps grew in the telling. Since reading and writing were enjoyed by few, the tales of strange sea monsters, origin-

ally based upon true facts, were easily distorted and magnified before they were finally reduced to the written word or the printed illustration. Moreover there were those among writers who needed no facts on which to base their descriptions. Not for nothing was Herodotus known as the father of all liars.

Propagation of fallacies

The older zoologists also copied one from another, with none of the modern scientific skepticism. The arm chair was more suited to the early naturalist than equipment for exploring in the ocean and the written or spoken word was the source of nearly all his scientific truth. Pliny copied Aristotle and others copied Pliny so that when mistakes were made they were propagated and new ones crept in. By the time printing was invented there were fairly extensive manuscript sources of information on travel and natural history which were not far removed from myth, though originally based on fact. Such was the "Voyages and Travels of Sir John Mandeville." In fact, even Sir John himself appears to have been imaginary.

In such ways the legends of the North Sea arose. To the peoples of northern Europe, the sea was the abode of krakens, sea serpents and mermaids. The descriptions and published illustrations of these are fantastic, but in them can be seen dim resemblances to such creatures as the whale or the giant squid, the factual basis of the original tale.

Mermaids and Sea Serpents

It is not always easy to separate these sea monsters into real and imaginary creatures. The mermaid, though fabulous, may actually have been derived from sailors' encounters with the living dugongs and manatees, or sea cows, mammals which bear and suckle their young in the sea or at the mouths of rivers. Like-

MERMAIDS AND MERMEN *were taken quite seriously at one time. Probably the real basis for this legend was the Mediterranean sea cow or dugong.*

wise the longlived belief in sea serpents may have some basis in fact, though the fact may bear as little resemblance to the story as the sea cow does to glamorous tales of mermaids.

The sea serpent story returns phoenix-like every so often, sometimes in special versions such as the Loch Ness monster of Scotland. Many explanations have been given. Some consider that imagination has created it out of a large oarfish, a whale, a giant squid or a group of porpoises swimming in line so as to give the undulating appearance of a large serpent. Others have seen it as the rare appearance of a prehistoric reptile such as an ichthyosaur or plesiosaur. The recent discovery of the coelacanth, a fish hitherto believed long extinct, has given a certain impetus to this belief. There are other strange opinions.

Birds from Barnacles

There is a curious old idea about the barnacle which dates back to the 11th century. The tale, recounted by Mandeville and others, relates that this sea-creature, normally found growing on docks or the underwater part of a ship's hull, was also found on trees. Moreover, at certain times these tree-growing barnacles gave rise to young in the form of geese, which were set loose and flew away. Actually, there are, in the sea today, barnacles which have a long stalk vaguely resembling the neck of a goose, while the shelly cover resembles the wings. Travellers finding these attached to driftwood may well have started the story on its way to legend.

SEVERAL ANCIENT AUTHORS *describe the barnacle which grows on trees. As the illustration shows, the barnacle was believed to grow miraculously into a goose. There was a factual basis for this strange tale.*

Strange though these myths and exaggerated truths are, the real monsters of the sea are even more monstrous in appearance, though little known to most people, even to seagoing people. The giant squid, measuring over 70 feet with tentacles extended, is an undoubted scientific fact. Some deep-sea fishes, with horrible mouths and able to engulf more than their own weight in a single prey, are worthy illustrations to any ancient sea legend (see Vol. I, No. 3, page 25, *Set a Fish to Catch a Fish*, and page 59, *Big or Little*).

Plankton Monsters

Some of the most monstrous living things of the sea, in the sense of bizarre appearance, are quite small, even microscopic. The plankton or

OLD ACCOUNTS *of whales explain that the blowing of trumpets, as in this illustration, is the best way of driving them off. The throwing overboard of barrels, to be swallowed by the whales, was also supposed to prevent trouble. The resulting indigestion was said to disperse these dangerous creatures.*

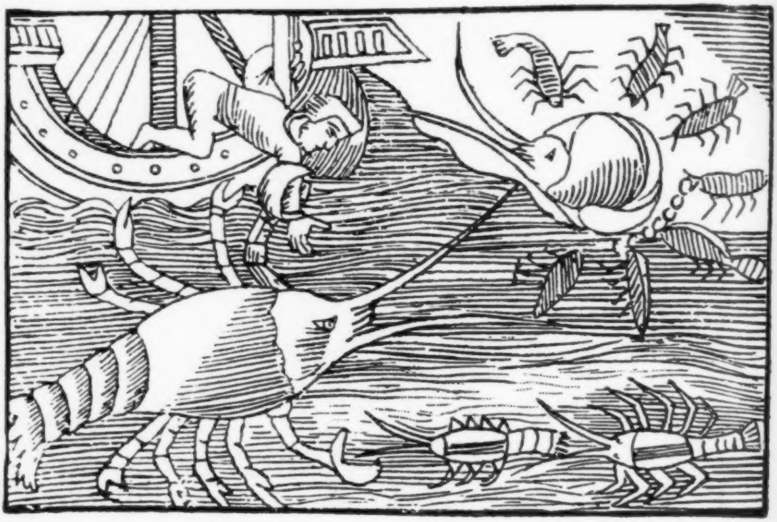
tiny sea plants which are the basic food or pasturage of the oceans are strange enough in appearance. Even stranger are some of the small many legged crustacea which in turn feed upon the plankton. The arrow worms or chaetognaths have elongated torpedo shaped bodies with streamlined fins and jaws armed with fierce spines. Yet they are less than an inch long. One eyed creatures as strange as the mythical cyclops, and many weird patterns of the jellyfish and the Portuguese Man-of-War abound in the oceans.

Seagods and Seaworms

By a strange reverse twist, the names of mythical creatures, gods or human beings, have been given to sea creatures by the natural historians of the last century. Amphitrite was the wife of Neptune or, rather, of his counterpart Poseidon and symbolized the sea, meaning, in effect, the erosion of all shores. Her name is carried today by a seaworm, living in a tube buried in sand. For some reason the marine worms have been particularly well favored with classical names. One family of them are the Nereids named after sea nymphs. The father of these nymphs, Nereus, was a sea god, with seaweed for hair, who lived in a submarine palace in the Mediterranean. His wife, Doris, is the namesake of a sea slug, weirdly strange in appearance except perhaps to the marine scientist who is used to such things. Galatea, a daughter of Nereus, has similarly provided the name for a creature which appears half crab and half lobster.

Floating Sea Snails

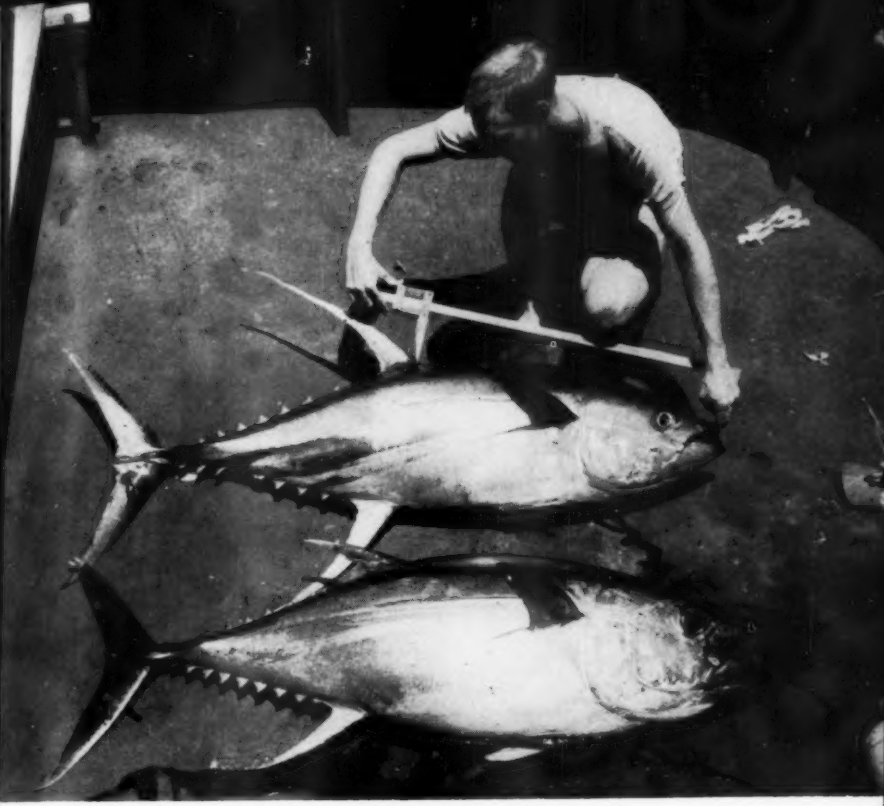
Another sea god, Glaucus, was a Boeotian fisherman who taught Apollo the art of soothsaying. To a marine biologist, though, Glaucus is a strange little transparent sea snail, which swims without a shell, in the open sea. Other names are more



THE NORTH SEA KRAKEN *or polyp was variously described and illustrated. Sometimes it had the appearance shown above. Possibly the origin of this legend is the giant squid known to exist.*

clearly appropriate. Neptune's horse, Hippocampus, had a fish-like tail for the hinder end of its body, and the fishes which bear the same name do have heads which strikingly resemble a horse. But the sea shell called Venus would probably not appear particularly endowed with beauty except to a shell collecting fan.

The scientists a century or more ago who named these creatures obviously had a good knowledge of classical mythology and an interest in fabulous monsters. Today most marine biologists are more interested in the everyday creatures, in how and why they behave as they do and in the part they play in the complex relationships of food and growth in the sea. But interest still lies in the little explored deeps and in continuing the task of making the huge inventory of the living things of the ocean. With continued exploration it is just possible that the sea serpent may turn out to be not pure imagination or honest illusion, but a strange prehistoric survivor, though this is not considered likely. Perhaps other so-called extinct creatures may turn up as our methods of catching and exploring improve, just as the coelacanth did.

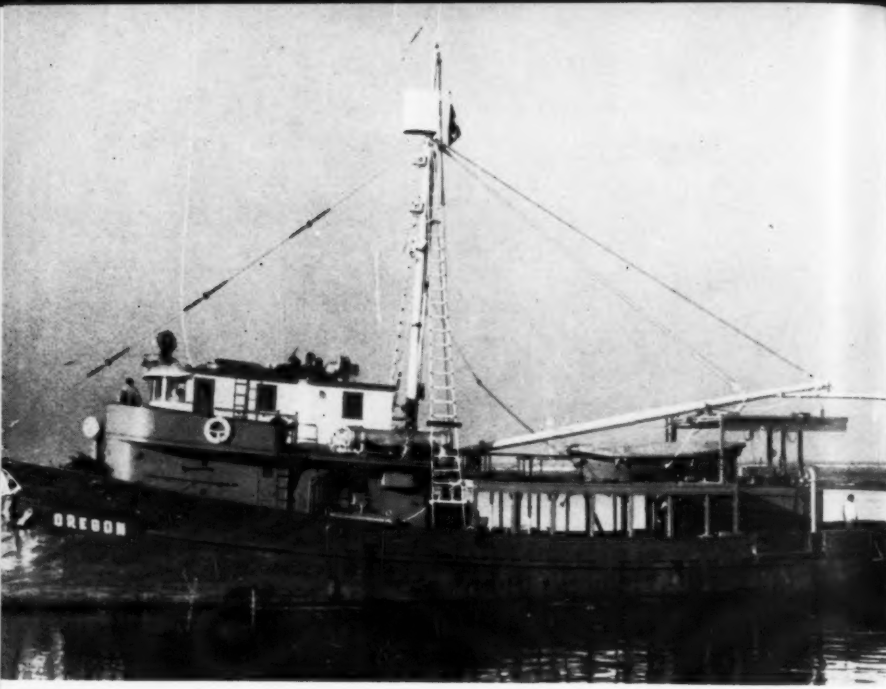


MEASURING TUNA *on board the U.S. Fish and Wildlife vessel* Oregon. *A yellowfin is shown in the background, with a big-eye tuna in the foreground.*

The Food of Tunas

By DONALD DE SYLVA
The Marine Laboratory, University of Miami

WHETHER we know a tuna by its powerful surge of energy as it rips off yard after yard of line from the angler's reel or whether we have seen it lying limply in a can on the kitchen table, we still may tend to underestimate the value of this benevolent beast which contributes so substantially both to the welfare and to the angling enjoyment of peoples



U.S. Fish and Wildlife Service *research vessel* Oregon, *which has been conducting extensive investigations for tuna in the Gulf of Mexico and the Caribbean.*

all over the world. The great annual international tournaments at Cat Cay in the Bahamas and at Wedgeport, Nova Scotia, which are sponsored solely for the quest of the giant bluefin tuna is evidence for the gaminess of this fish. Similarly, charter boats especially equipped to capture albacore and other related species of tuna are a regular feature in some parts of the United States.

On the commercial side, for years many countries such as Japan, Spain, Italy, France and Turkey have been fully aware of the highly nutritious value of these fishes and their delicious and delicate flavor and have made tuna or tunny fishing one of the prime objects of development. Recent wartime improvements and the general increase in the number of specially designed tuna clippers have opened up new horizons for this valuable, virtually unexploited resource. In the United States previous to 1946 tuna was relatively unknown as a staple food. In 1929 the pack of canned tuna in the United States was only about 31 million pounds. This figure rose very gradually until the pack reached about 94 million pounds by 1946. By 1952 the figure had nearly doubled to a total canned pack of 180 million pounds, and it is evident that this figure will be greatly surpassed.

Different Kinds of Tunas

From the above it would seem that a great deal of information must have been accumulated about the habits and biology of this group of fishes which are so important in the economy of the world. Yet science must admit that there are simply not enough facts available to piece together a full account of the life histories of such important tuna species as albacore, yellowfin, bluefin, bigeye and skipjack. Only by means of careful and painstaking research on the biology of these species can we hope to make use of the knowledge of their habits in order to locate and catch them more economically.

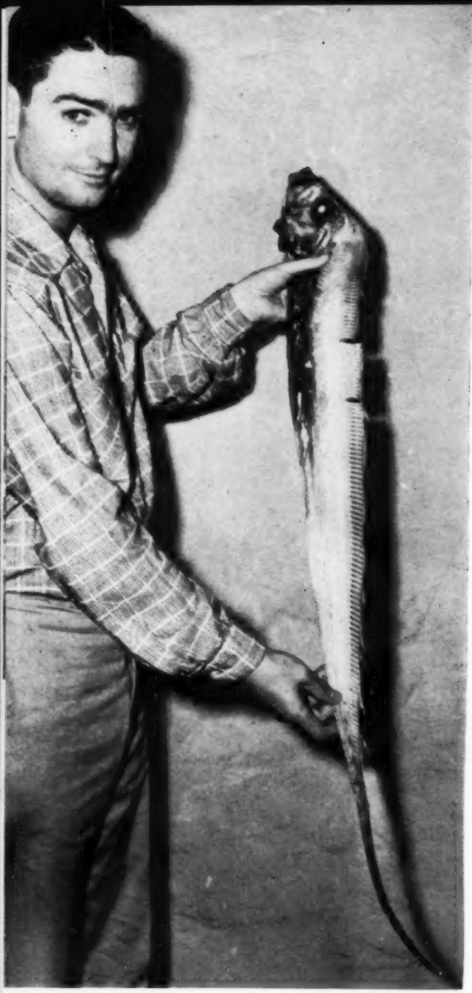
What Don't We Know?

A few of the facts we need to know better are: how fast do tuna grow, where and when do they spawn, to where and how fast do they migrate, what kind of habitat do they prefer, and what do they eat? Perhaps the answer to this last question, "What do they eat?" will enable us to answer some of the previous questions. Does this one item have a definite bearing on all of these others? Just how important a part do their food and feeding habits play in the life of these mystery fishes?

Coincidental with the immense growth in popularity of these fishes there has been, fortunately, a corresponding interest in their food and feeding habits, and there are many reasons for such an interest. It is possible with reasonable accuracy to infer what the tunas eat and what their preferences are at the different stages of growth. Thus, knowing the kinds of organisms eaten, it may be possible to locate the habitat of these particular organisms and therefore the habitats visited by the tunas. It is then conceivable that by knowing the relationship between the fishes and their food that the tunas could be exploited more readily by the use of appropriate lures or gear which would simulate the normal food if fished at the usual depths for feeding. When tunas are scarce perhaps their scarcity is due to their pursuit of food into different regions, and therefore it would be important to know the distribution and abundance of this prey. The discovery of young and juvenile tunas in the stomachs of the adults suggests also the possibility of finding in these stomachs new or rare species of other kinds of fishes, so that valuable information on the habits and life histories of these rare species may be gathered. In fact, tunas are far better instruments for collecting specimens than the nets and the ordinary collecting apparatus used by marine scientists.

Diverse Diet

The earliest observations on the food of tunas were made by Japanese scientists in the Bonin Islands of the Pacific about 1915, under the direction of Kamakichi Kishinouye. Since tunas have long played a major role in the economy of this great fishing nation it was, of course, imperative for Japan to learn about the habits of these fishes. In order to study the food of the yellowfin, albacore and bigeyed tuna, stomachs were obtained from specimens caught on longline gear and were subsequently ana-



DON DE SYLVA, *Miami ichthyologist, shows a dealfish (Trachipterus), sometimes eaten by tunas.*

lyzed in the laboratory. Although the tuna caught did not vary much in size, the variety and range of size of their food was almost unbelievable. The tunas averaged three to four feet in length. Yet the smallest food organisms encountered were tiny snail-like creatures called heteropods, averaging about a third of an inch in diameter, and the largest organism was a kind of ribbon-shaped fish about seven feet long which had been bent over several times in a tuna's stomach. However, the Japanese studies showed that the bulk of the stomachs contained medium sized plankton, and of these, crabs and shrimps were predominant. Other organisms found were squids, crustacea, lantern fishes and other fishes, many of which were of the deep sea variety which possessed luminous organs. There were also larval and juvenile stages of the spiny lobster, young of the one-ton ocean sunfish which were less than one-half inch long, juvenile tunas which previously had been seen only rarely, flying fishes, frigate mackerel, and even spearfish! With this bizarre assortment of information there began a general interest in cutting open fishes in order to see what they had been dining upon and how this knowledge might give clues for baiting their fellows.

The investigations were extended to other areas of the western Pacific and also the South Seas. As the work progressed the list of the food of tunas increased, and bit by bit valuable information could be pieced together. The Japanese found in the Celebes Sea that 17 families of fishes were taken from 57 specimens of yellowfin tuna. In this area, squids and shrimp-like squillas were also an important part of the food. A strange assortment was found. Anchovies, cowfishes, triggerfishes, barracudas,

small tunas, needlefish, jellyfish, eels, milkfish, frigate mackerel, gurnards and herring were listed. There was even a large assortment of pebbles and dead leaves. These latter objects appeared to be definite proof that, as some scientists had formerly believed, tunas occasionally feed on the bottom.

New groups were constantly being added to this potpourri of animate and inanimate objects, and the diversity encountered seemed to be without bounds. Reef fishes and invertebrates were also included in the diets. There were several kinds of lobsters, surgeon fishes, butterflyfishes, squirrelfishes, cowfishes and snappers. New types of deep-sea fishes, rare tunas, shrimps and floating snails were present in varying amounts. The common appearance of adult reef fishes seemed to indicate that tunas were almost as at home near reefs as they were in the open oceans.

Preferred Feeding Depths

The Japanese also discovered that each species of tuna not only swam at certain depths but that each of these species dined upon certain preferred types of food. For example, the albacore was found to swim at about 80 meters and fed upon plankton, shrimps and small fishes. Subsequent studies on the albacore showed one of the important types of plankton food to be krill. Krill, or euphausiids, are small shrimp-like animals, averaging less than one inch long, which are well-known as being one of the important constituents of the food of certain whales. The importance of krill in the economy of the sea has probably been greatly underrated, for krill is one of the most important items in the albacore diet, as well as other fishes. Other organisms found in the albacore stomachs were crabs, sardines, octopi and jellyfish.

The black tuna, in contrast to the albacore, seemed to be more of a surface feeder. The bigeye tuna, on the other hand, was found to be a deepwater swimmer, from 20 to 120 meters. Nevertheless it also fed upon surface fish, including sauries, a distant cousin of the flying fish, and bonitos. The yellowfin tuna, like the black tuna, seemed to prefer surface waters and were often taken quite close to land. This species was found to contain flying fishes, as well as the usual varied *hors d'oeuvres* of other creatures. It was said that often the stomachs of yellowfin tuna would be completely packed with squilla larvae, yet the tuna could still be caught on a hook and line, a feat which only further proves the gluttony of these animals!

The European Bluefin

While this work was still being conducted by the Japanese, similar interest arose in other parts of the world, namely France and Italy. In their studies of the habits of the giant horse-mackerel or bluefin tuna in the Mediterranean, Sella and other Italian biologists found it was predominantly a fish eater. Not only anchovies, herring and mackerel, but also several kinds of the larger planktonic animals were found. It is said that in the Straits of Messina that the giant tuna become so glut-

Often the long lines *used for tuna fish exploration bring in sharks. This head on view is of a 9 ft. mako shark, caught on tuna long lines in the Gulf of Mexico.*

ted on the tiny krill in the autumn and winter that they let themselves be easily approached and harpooned by fishermen.

In the meantime, the French under the supervision of R. Legendre, had been carrying on detailed studies in the Gulf of Gascogne and had contributed greatly not only to the understanding of the food habits of albacore (le Germon) but had succeeded in obtaining many new and rare species of fishes and squids from the stomachs of this efficient specimen collector. In the Gulf of Gascogne, a shrimp-like amphipod appears to be extremely important as food for tunas, and it is reported that immense banks of these "crevettes" extend over many miles of water and make the water appear red. In these studies, however, fishes consituted the most important food. Amphipods and sauries mentioned as being important in the Pacific were the most important species found. It was noticed by the commercial fishermen that the greatest catches were made when the sauries were most abundant. Nevertheless the stomachs contained a similar magpie-like collection of those found in tunas elsewhere. To add to the diversity of organisms, 28 different kinds of squids were taken and these appeared to form an extremely important part of the total diet.

California

Research on the albacore off California which was conducted by J. L. McHugh at the Scripps Institution of Oceanography, showed a striking similarity of food habits between the two widely separated populations of California and France. Among the considerable variety of food reported were the Pacific saury, squids, krill, and even hake.

Western Atlantic

The presence of hake in tuna stomachs was also noted by Jocelyn Crane working in New England on bluefin tuna. Of 34 stomachs examined, 26 contained hake, 4 had seaweed and 3 had squid. A small amount of krill, herring, and rosefish were also found. Off Cat Cay, Bahamas, the stomachs of large bluefin tuna revealed freshly ingested large squids and also squid beaks and radulae. These are the rasp-like tongues of bottom living snails. The presence of these radulae indicated that these fish had at some time previous to their capture been feeding near the bottom. This work is being continued under the direction of Gilbert Voss, who supervises gamefish research at the Marine Laboratory of the University of Miami.

In the western Atlantic, observations were made by William Beebe, of the New York Zoological Society, on the food of the Atlantic blackfin tuna and the yellowfin tuna. Since both of these species tend to be rather rare at certain times, it was of greatest scientific importance to determine whether or not their food habits might explain their periodic disappearances. As in other studies, the most important groups found were various kinds of fishes. Several luminous species of squids were encountered, which inhabit depths of a quarter mile or more.

PUTTING A LARGE YELLOWFIN TUNA *into the brine well. Exploratory work by the U.S. Fish and Wildlife Service has given much information on food of the different kinds of tuna.*

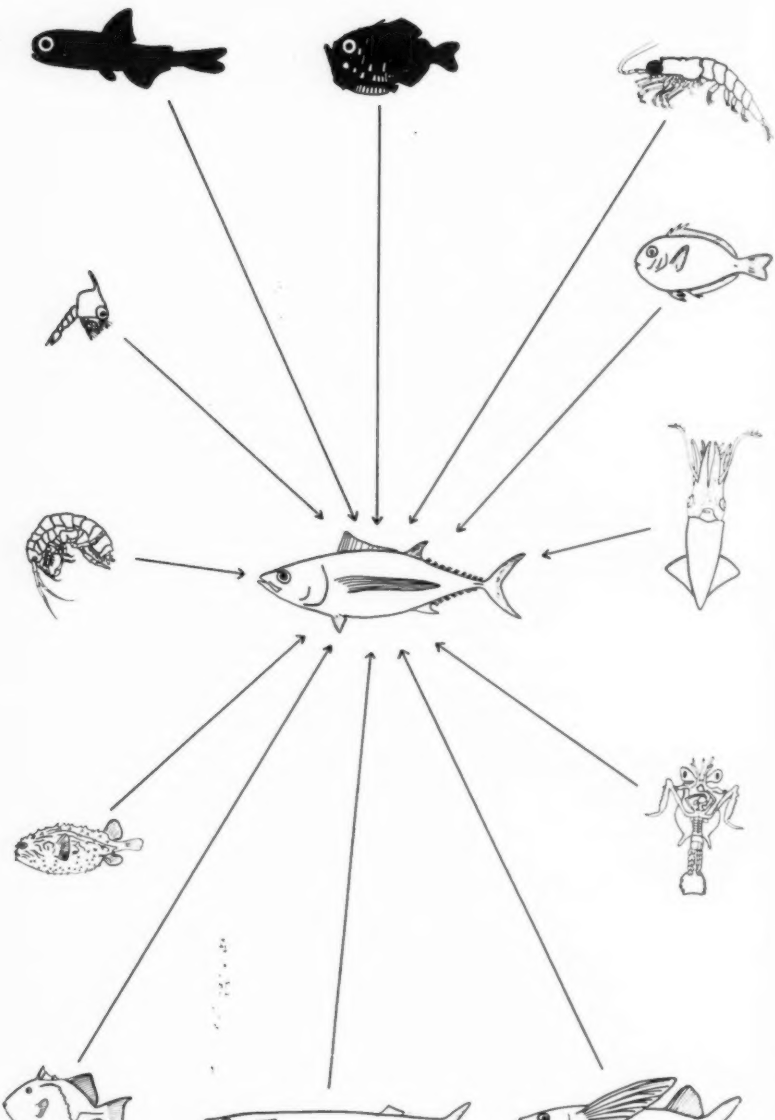
Tiny squillas of less than ½″ seemed to predominate in volume in many cases, and it was concluded that these tiny organisms were actively sought by yellowfin and blackfin tuna. Preliminary observations by the U.S. Fish & Wildlife Service in the Gulf of Mexico on the food habits of yellowfin tunas indicated that these tuna eat almost everything. There were even diatoms, the microscopic single celled vegetation of the plankton.

Recent Pacific Investigations

In the Philippines, investigations by Ronquillo on the diet of 115 yellowfin tunas included not only the usual surface living conglomeration but in addition, certain lantern fishes and hatchet fishes. These were formerly considered quite rare but were found in abundance in the stomachs. The abundance of shore and reef fishes probably explained why tuna can be caught in especially constructed fish corrals along the coasts of Batangas and Zamboanga Peninsula. The fish diet here included the plectognath fishes, or filefishes, blowfishes, boxfishes, and trunkfishes. This group is characterized by thorns, spines and hard coverings. It is generally considered to be a poisonous, unpalatable and worthless group.

Federal and State agencies of the United States investigating the yellowfin tuna in the Central Pacific found that about half of the diet of this species was composed of fishes, about one quarter squids and about one quarter crustaceans. Of all these,

SPECIAL HAULING GEAR *is used for bringing in the long lines used in tuna exploration. The line, with its numerous hooks, is coiled into the basket in the foreground.*



SOME OF THE MORE COMMON TYPES *of tuna food. The albacore, pictured center, is one of several kinds of tunas which feed upon some of these organisms. Upper left and clockwise: Myctophid, or lantern fish; hatchet fish; Euphausiid, or krill; surgeon fish; squid; larval squilla, or Stomatopod; flying fish; saury; triggerfish; spiny boxfish; amphipod; larval crab, or zoea.*

there were 38 fish families and 11 groups of invertebrates represented. The greatest volume of organisms were found to be minute crab larvae, and more than 75% of the stomachs contained organisms each weighing less than ½ gram, or about two-hundredths of an ounce apiece! In general it was found that the size of the organisms eaten depended upon the size of the tuna, but that even relatively large fish (3-4′ long) would gorge themselves on the tiny crab larvae. Again, as in the Philippine tunas, the spiny plectognaths made up the bulk of the fish diet.

Studies in Spain and Other Areas

Moving over to the other side of the world once more, recent studies by Spanish ichthyologists on the bluefin tuna in the Mediterranean and neighboring areas have shown that these giant tunas feed extensively in these areas on squids, schools of sardines, king mackerel, mullets and flying fishes, among others. In the North Sea, frigate mackerel, albacore, cod and even sharks formed an important part of the menu.

Although observations on the food of tunas from the southern hemisphere are fairly limited, yellowfin tuna off Mauritius and the Seychelles in the South Indian Ocean had, in addition to the usual items, engulfed the swift and beautiful dolphin fish. This is further testimony to the astonishing speed of tunas, the greyhounds of the sea! In Australia, the diet of southern bluefin tuna did not differ greatly from the general pattern of feeding of tunas in other regions.

An interesting addition to the variety of food eaten by tunas is the large number of seahorses and pipefishes found in yellowfin tuna from Hawaii, along with juvenile surgeonfishes. The bony armor of the seahorses and pipefishes would appear to be discouraging, yet a bonito from the Philippines was found to contain thirteen deepwater pipefishes!

Wide Range of Appetite

This great mass of information boils down to the general conclusion that a certain number of basic and important features are common to the food and feeding habits of tunas all over the world. Tunas appear to eat anything, and probably eat whatever is most abundant and those things easiest to obtain. The presence of adult tuna is probably related to the total amount of food present in any particular area rather than to the kind of food. That they feed anywhere is shown by the presence of animals which are characteristic of the open ocean or the coral reef, the surface waters or the deep sea, and occasionally animals which are found on the bottom. At the surface, they appear to feed on crabs, shrimp larvae and fish larvae, while they feed beneath the surface on squids and fishes. In general, the juveniles feed mainly on crab and shrimp larvae, while the adults feed upon fishes and squid.

There appears to be a certain universal pattern to their feeding, and that is the presence of certain major groups of animals: sauries, amphipods, squids and krill for albacore; plectognaths, squids, squillas, deepsea fishes, crabs and shrimps for yel-

lowfin and blackfin tunas; squids, sardines, flying fishes, herring, and krill for bluefin tuna. For all tunas, the important groups, as a whole, seem to be squids, krill, amphipods, shrimps, crabs, squillas, deepsea fishes, sauries and plectognaths.

How Can We Catch More Tuna?

As a practical consideration to some of the above points, it may be wondered how science can use these valuable facts which have been gathered from all over the world. Are they sufficient to enable us to draw conclusions and to predict, or should we continue to accumulate data? It would be illogical to say that we have accumulated all the data we need to predict, for this is seldom true. However, although only a fraction of the tuna populations have been studied, we may make certain inferences, with reservations, about other tuna populations. From a practical point of view, we would want to know the answer to two basic questions: (1) On what organisms do tunas feed, and (2) at what depths do these organisms live? We already have an idea as to the first. The answer to the second will be the object of marine scientists in future studies. Which of these organisms on the menu, then, we may ask, could we use to catch more tuna? Could any of these be used for bait? The krill, the amphipods, the shrimps, the crabs, the squillas, the deepsea fishes and the plectognaths seem to be too small for practical usage, leaving us with squids and sauries. Neither of these has been fully exploited as bait, yet both are important groups as tuna food. While the saury is more typical of albacore food, squids seem to be universal as part of the diet of all of the tunas.

The University of Hawaii and the U.S. Fish & Wildlife Service, in their experiments with attracting tuna to certain stimuli, found that, among others, extract of squid elicited a vigorous feeding reaction, although not definitive, since vision seemed to play the most important role in the tunas' feeding. They found that motion was extremely important and experimentally coated strips of macaroni and agar with aluminum powder and got good results in attracting tunas!

Is the conclusion too far-fetched that the white, rubbery appearance of macaroni in the water simulated the trailing tentacles of a squid as it propels itself through the water? Perhaps some enterprising angler will hit on the bait of the year and the catch of the tournament.

The Fisherman Fished

By CHARLES E. LANE

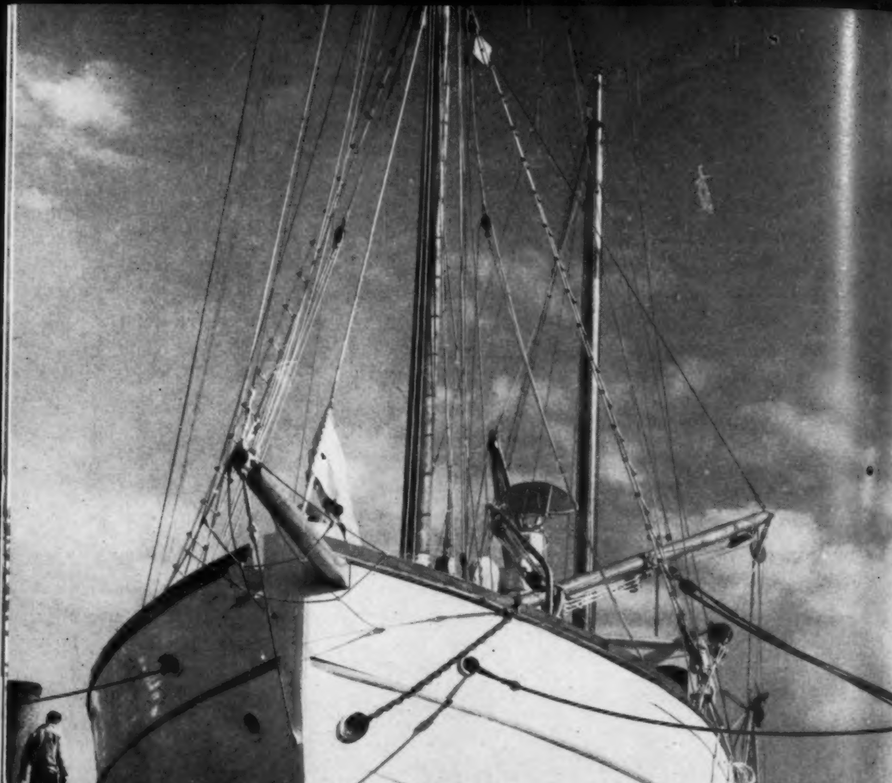
The Marine Laboratory, University of Miami

DURING THE NIGHT of February 14-15, 1956, while the vessel was west of the island of Bimini, the crew of the R/V GERDA observed that she was making water at a rate which was greater than usual. It was, however, possible to continue the cruise by pumping at more frequent intervals. On her return to Miami the vessel was hauled out and found to have suffered a penetration by the bill of a blue marlin.

Nearly holed fuel tank

The skin of the ship at the site of the damage is nine inches thick, composed of beech planking 2½ inches, oak frames 5 inches, and an inch and a half pine ceiling. The fragment of the bill which was recovered measured 8¼ inches in length and was broken off flush with the outside surface of the planking. Since the puncture occurred between the frames, the total amount of wood

OUTSIDE PLANKING *of* Gerda, *showing marlin spear broken off in the encounter.*



Research vessel Gerda *shown in dry dock for inspection after her encounter with a marlin. These fish have been known to kill anglers.*

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which was punctured by the rostrum was only 2½ inches of the toughest beech, and perhaps half an inch of pine ceiling. It is fortunate that the ceiling was not completely broken through because directly inside the ceiling is a main fuel tank.

As can be seen in the illustration, the planking was split for a distance of at least eight inches. For much of this length the split was at least ¼ inch wide. This provides a ready explanation for the suddenly augmented rate at which the vessel took on water.

It is worthy of note that none of the crew remembers any special jolt, impact or concussion which could be related to this "attack." It is, of course, possible that the contact could have coincided with research activities of the crew which engaged their entire attention.

Other attacks by fish

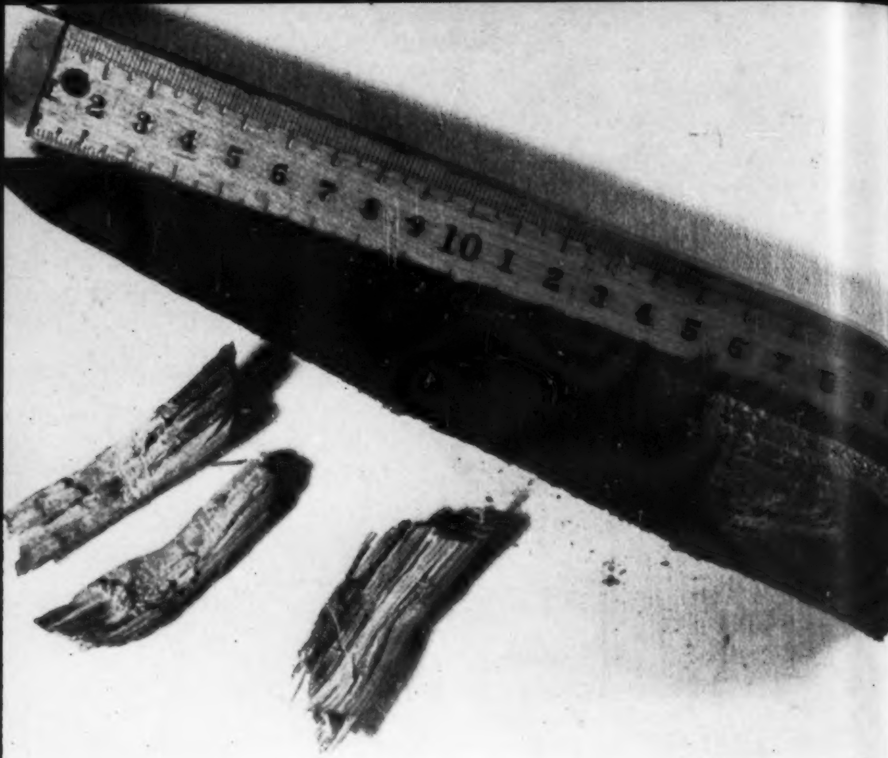
Lest it be assumed that this occurrence is unique, it should be recalled that Dr. E. W. Gudger, the indefatigable chronicler of ichthyological natural history, records many well-authenticated instances of apparent "attacks" by spear fishes on vessels of many kinds and sizes. His record case may well be quoted *in extenso*:

"Now comes the most remarkable of all cases of penetration—18.5 inches through hard wood, 14.5 inches of it through dense oak. J. V. C. Smith (1843) definitely states that when the South Seas whaler *Fortune* came home to Plymouth, Mass., in 1826, the butt of a round blade was found protruding from her copper. Here follows the condition of the ship as stated by Smith. Careful examination showed the bill to have penetrated through the copper sheathing, an inch board sheathing, a three inch hardwood plank, the solid white oak timber of the ship 12 inches thick, through another two and a half inch hard oak ceiling plank, and lastly to have perforated the head of an oil cask, where it remained immovably fixed so that not a single drop of oil had escaped."

Fisherman killed by broadbill

The same authority documents the following instance of a fisherman being killed by the assault of a broadbill swordfish upon a small boat:

"Absolutely authentic is the next account which concludes with the certificate of the attending physician. The sword was preserved and sent to the U.S. National Museum. On Monday, August 9, 1886, Captain F. D. Langsford sailed out of Lanesville, Mass., in the schooner *Venus* (12 tons) with a crew of three men, in pursuit of swordfish . . . About 11 a.m., in Ipswich Bay a fish was seen. The captain, with one man, taking a dory, gave chase, and soon harpooned the fish, throwing over a buoy with line attached to the harpoon, after which the fish was left and they returned to the vessel for dinner. About an hour later the captain, with one man, again took his dory and went out to secure the fish. Picking up the buoy, Captain Langsford took hold of the line, pulling his boat toward the swordfish,



PART OF MARLIN SPEAR, *broken off in* Gerda's *2½ inch planking. 8¼ inches penetrated the hull. The force was sufficient to crack adjacent planks and to drive fragments of wood inside.*

which was quite large, and not badly wounded.

Attacker Attacked

"The line was taut as the boat slowly neared the fish which the captain intended to lance and thus kill. When near the fish, but too far away to reach it with the lance, it quickly turned and rushed at and under the boat, thrusting its sword up through the bottom of the boat 23 inches. As the fish turned and rushed toward the boat the line was suddenly slacked, causing the captain to fall over on his back, and while he was in the act of rising the sword came piercing through the boat and into his body. At this time another swordfish was in sight near by, and the captain, excited, and anxious to secure both, raised himself up, not knowing that he was wounded. Seeing the sword, he seized it, exclaiming, "We've got *him*, anyway!" He lay in the bottom of the dory, holding fast to the sword, until his vessel came alongside, while the fish, being under the boat, could not be reached. Soon the captain said, 'I think I am hurt, and quite badly.' When the vessel arrived he went on board, took a few steps, and fell, never rising again."

This account could be extended

to include reports of attacks on passage-making vessels on the high seas, on fishing vessels and on dories and dinghys. Well authenticated narratives are available from the Atlantic, Pacific and Indian Oceans and from the Mediterranean. Wherever, in short, the cosmopolitan bill fish are to be found here, also, have occurred incidents of the kind described here.

Are broadbills pugnacious?

The question naturally arises whether these attacks should be attributed to the innate pugnacity of the fish or whether they may be explained in some other way. In this connection it should be recalled that albacore, bonito and other oceanic fish have frequently been described as seeking the shelter of a vessel at sea, often accompanying such a craft for thousands of miles. There are numerous accounts of spear fish attacks on such masses of schooled fish. An infrequent elderly, ill or injured spear fish may accidentally strike the adjacent hull while seeking to kill his legitimate prey. It is rather remarkable that such events are no more frequent than they have been reported.

It seems quite clear that the attacks by injured or infuriated harpooned fish upon dories or upon larger fishing vessels generally occur because the vessel happens to be in the path of a blind, unreasoning reflex attempt to avoid a painful stimulus. Certainly one should avoid attributing intellectual qualities of cunning, revenge, or crafty retaliation to animals whose mental endowment is primitive at best.

What do you Think?

THE EDITOR wishes to acknowledge the many helpful criticisms and suggestions which have reached him in response to an invitation in earlier numbers of the *Bulletin*. It is hoped that these expressions of interest will continue, in order that the *Bulletin* may be continually improved towards its objective of presenting up-to-date information on the progress of marine science and exploration of the sea to the rapidly growing membership of both scientists and laymen. Your ideas and criticisms will be appreciated. If you have suggestions as to how the Foundation may better serve its purpose of encouraging and developing ocean science and discovery they too will be most welcome.

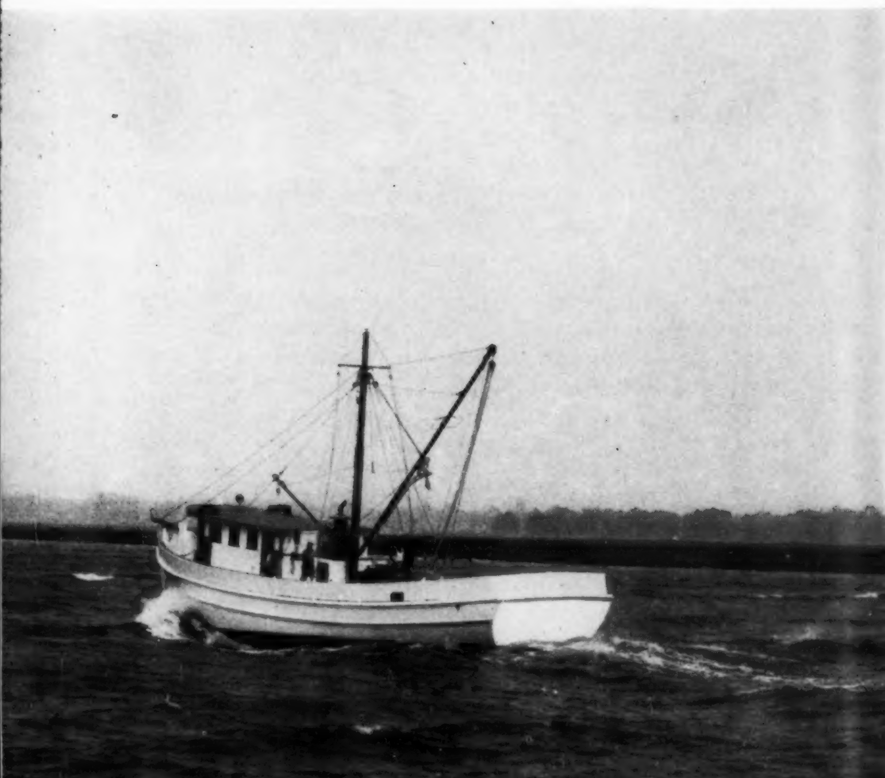
Are New Shrimp Boats Acomin'?

By Edwin H. Mairs
Coconut Grove, Fla.

Viewed from an airliner, flying at night over the Gulf of Mexico, the shrimp fleet appears as a misplaced city, situated in the middle of nowhere. Operating in concentrated groups of from twenty to two hundred vessels, with navigational lights glowing and flood lights lighting up the afterdecks, it resembles a small Atlantis. It is, in fact, a small, hard-working community on the night shift, endeavoring to satisfy America's increasing demand for fresh and processed shrimp. How did it develop and what design of hull carries its traffic?

Although it is the largest year-round fishery operating on the American coasts, the present-day Southern Shrimp Fishery is also the youngest, a product of the period since World

Modern *Gulf of Mexico shrimp boat. This type is easily recognized by its high bow, pronounced sheer and forward deck house. Has the time come for scientific improvement in design?*



War II. But the fleet, itself, is much older. From small beginnings in the early part of the twentieth century, the fleet has grown from a negligible number of motor boats, operating seasonally in bays and rivers, to an armada of 50-75′ seagoing vessels, operating continuously on the inshore and offshore shrimp beds. The motor boats, two decades ago, numbered in the hundreds. The offshore vessels, today, number in the thousands. In St. Augustine, one builder alone has constructed over five hundred and twenty-five 50 to 70 footers since 1947—a remarkable peacetime accomplishment!

The Shrimp Boat

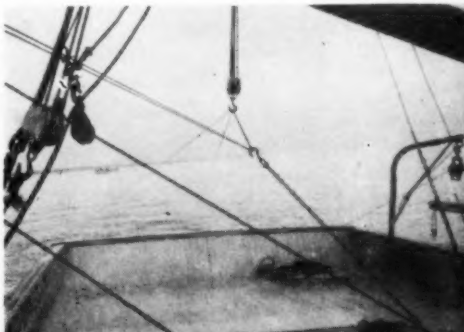
In the development and maintenance of a fishery such as this many factors are included. Exploration, biological research, and the improvement of boats and gear go hand in hand with the betterment of handling, refrigeration, transportation and marketing. So the marine sciences applied to resources of the sea become highly diverse. One of the most interesting aspects of this is marine architecture, the exhibition of fishing craft and the improvement of design.

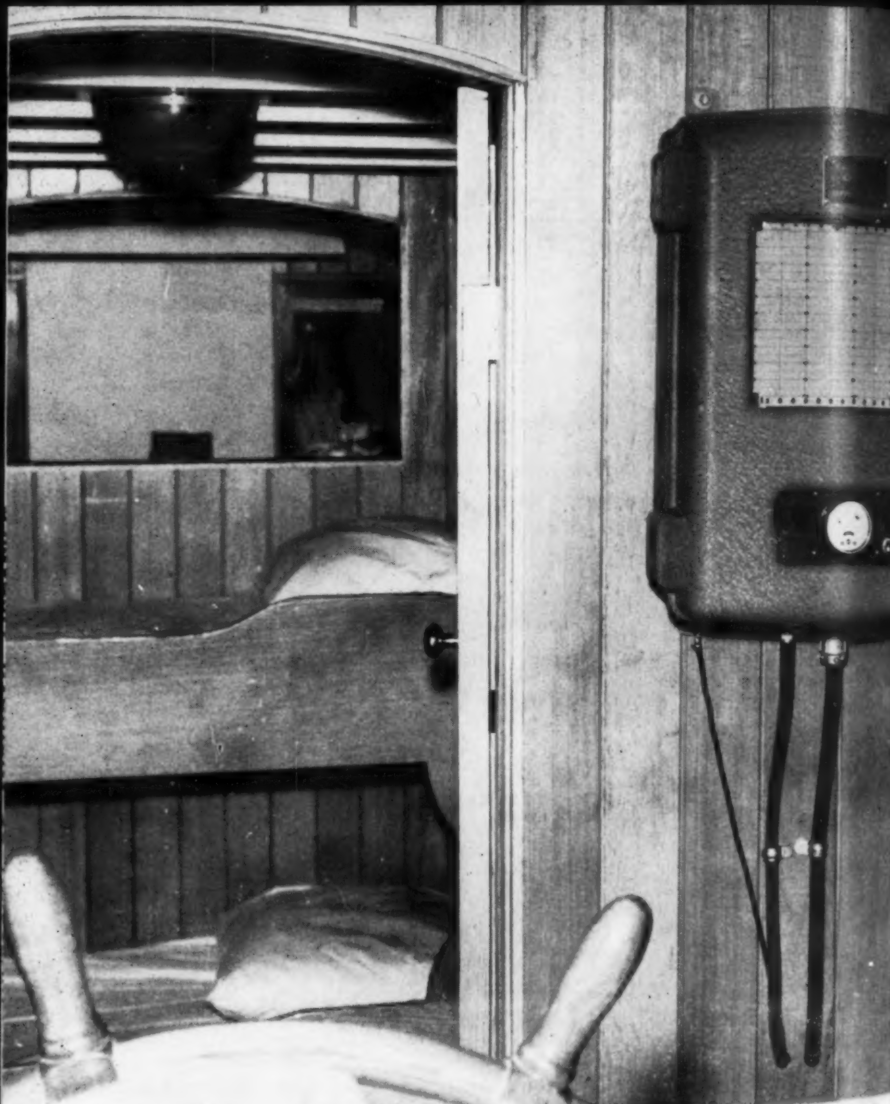
The vast bulk of the fleet is composed of the Florida-type shrimper, a familiar sight on the Atlantic and Gulf Coasts from North Carolina to Mexico. Its high bow, pronounced sheer, and forward deck house give it a romantic, jaunty appearance, peculiar to its type. Even a person unfamiliar with boats can distinguish the Florida shrimpers from other fishing and work-boat models. They are all Diesel powered. Their rig is a standardized trawler rig, developed within the fishery and easily handled by a crew of from two to five men. The larger vessels are outfitted and fueled to stay at sea for periods in excess of sixty days, and frequently do so when fishing the Gulf of Campeche. The majority are constructed of wood, although the use of steel is gradually gaining minor acceptance. A few are equipped with refrigeration equipment for processing and preserving the catch, but the average shrimper depends on ice to hold the shrimp in marketable condition. The Florida shrimper is so standardized in design, rig, lay-out and mechanical equipment that a crewman can easily change from boat to boat and be able to perform his work with but little time for acclimatization. As a model lending itself to mass production and standardization, the Florida shrimper is largely responsible for the tremendous growth of the South Atlantic and Gulf Coasts shrimp fishery.

Evolution of a Trawler

However, the type has its severe limitations. With a few outstanding exceptions, the vessels were not designed in the true sense of the word.

THE SQUARE STERN *and roomy afterdeck are characteristic of these boats.*





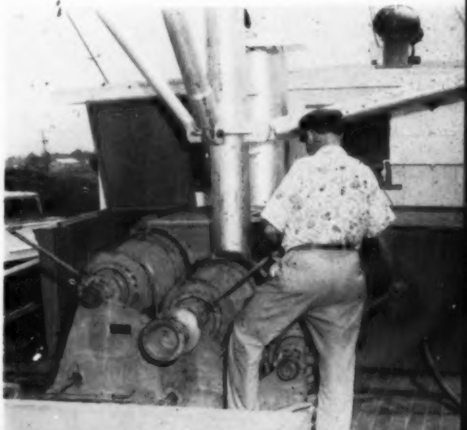
THE ENLARGED DECKHOUSE *makes communication between forward wheelhouse and working deck aft almost impossible. Modern aids, such as the echo depth meter shown above, have come into general use.*

They just "grew like Topsy." As shrimping moved out of the bays and rivers to the inshore fishing grounds near the home ports, larger 35-40′ versions of the old motor boats were built in order to cope with open sea conditions. A type developed, which was based on the local fish boats of Northeast Florida; their construction was concentrated in Fernandina and St. Augustine, Florida. Their model and construction were greatly influenced by the Mediterranean and Southern European backgrounds of the fishermen who settled in these ports. As the fishery grew and new fishing grounds were discovered further and further offshore, at greater distances from port, these inshore vessels were "blown up." Vessels as large as 75′ in length were constructed, using similar molds, similar layouts, and identical spars and rigging. Diesel power became universal and power winches were installed for handling the fishing gear. Many of the attributes of the smaller vessels were lost in this process, and all of their poorer features were accentuated. It is the opinion of many that the type over-reached its limitations when the 50′-60′ lengths were exceeded.

Too big for its Boots

The additional length, beam, and carrying capacity developed many characteristics which seriously affected the seaworthiness, safety, ability to fish under adverse conditions, and the economical operation of the vessels. The typical 65-70 footer has full under-water bow sections. Simplified planking developed a characteristic high bow which, contrary to common belief, is not an indication of seaworthiness but only serves to hamper the visibility. The rounded sections and lack of adequate flare in the topsides, result in a wet boat, which is subject to pounding and plunging in even moderate seas, due to lack of reserve buoyancy. The mid and after sections are very slack at the turn of the bilge, almost barrel-shaped, so that the boats are noted for their tendency to roll in a seaway, to the detriment of their fishing ability and the comfort of the crew. The lines aft, buttocks and diagonals, rise rapidly towards the transom, producing a squatting stern which not only affects the vessel's speed, but also causes trimming by the stern when loaded and when towing. The enlarged deck house almost prohibits communication between the wheel house forward and the working deck aft. As open winches are universally used, this results in a dangerous situation which has been responsible for many serious accidents to personnel. Construction methods and scantlines have not

A TYPICAL WINCH. *Open winches result in a situation dangerous to the crew.*



varied over the years and the specifications are nearly the same for both large boats and small, resulting in vessels with a useful life of but five to seven years. Most of the boats are underpowered, which is a factor affecting trawling efficiency and the time spent proceeding to and from the fishing grounds. Accommodations and living quarters have been little improved. The majority of vessels have no sanitary facilities, and are poorly ventilated. Spars and rigging are, as a rule, unchanged in capacity from those on the smaller vessels, aggravating the unsafe working conditions on board. In summation, reliance on custom and tradition in the construction of these larger trawlers has not resulted in a successful, economical, or satisfactory vessel.

Wanted, a new design

What is the next step? The fishery is still expanding in size of catch and scope of operations. In the past year, experimental work has discovered that shrimp can be found in deeper waters than those fished now—200 fathoms rather than 30 to 40 fathoms. It seems likely that, instead of relying on large numbers of mediocre vessels, the fishery is ready for the development of a new shrimper, properly designed, outfitted, and engineered to meet changing conditions.

As a designer who has had some experience with the Shrimp Fleet, it is the opinion of the writer that the time has come to plan a newly designed and larger shrimper, 80′ to 90′ in length. The present hull form must

A TYPICAL *50 ft. wooden hulled shrimp trawler, showing arrangement of boom, nets and rigging.*

be altered and refined in accordance with the latest scientific and technical knowledge. The forward sections must be made finer, with an effective flare topside to provide a dry bow with ample reserve buoyancy. Tank tests do not indicate that a V-bottom hull could be used to advantage. The midship sections should be hardened at the turn of the bilge to overcome excessive rolling. The run aft must be flatter to provide better speeds and less critical changes in trim when loaded. Ample power must be installed to enable free running speeds up to 10 or 11 knots and more effective towing speeds. A single screw with a variable pitch propeller has been the solution in other fisheries facing the same problems. Preferably, the deck house and quarters should be moved aft, leaving the waist open as a working deck, assuring easy, visual and vocal communication between it and the wheel house. The single mast could then be stepped forward of the midsection and the present Florida rig, which is efficient in its needs for manpower, could be easily adapted, with minor improvements, for use in this new position. Crews' quarters should be located topside, if possible, and living conditions improved. Below, the engine room should be well aft and an insulated, refrigerated hold provided amidship near the center of buoyancy.

The seasonal incidence of successful shrimp catches indicates that careful consideration should be given to the development of a dual-purpose vessel, capable of being used in other fisheries, as well as shrimping, without changing, or adding to, the crew. Experimental work is now being conducted in the Gulf of Mexico and the Caribbean, which will be of assistance in solving this problem. Construction could be either of steel or wood. In either case, scantlines and construction methods should be revised to produce a vessel capable of successful operation for a period of from fifteen to twenty years. A newly designed vessel, as outlined above, would rectify many of the shortcomings of the present shrimpers and could be constructed at an initial cost comparable to that of the Florida type.

With current losses of from 80 to 100 vessels per year, rising insurance rates, large crew turnovers, and longer voyages, the future holds little hope that the common Florida-type vessel will prove economical and efficient for operation in this expanding shrimp fishery. The industry is at a cross-roads, and its further success is hampered by the continued use of this traditional fishing boat. It is time for a change. Ship designers must do their part as well as food technologists, marine biologists and marketing experts if the fishery is to be maintained and extended successfully.

About the Authors

A NUMBER OF MEMBERS have suggested that we include a brief bibliography of authors. Suggestions such as this are very welcome and we hope to have more letters of this kind in the future. In response to these comments we give a short paragraph on the authors whose articles appear in the present issue.

CHARLES E. LANE

Dr. Lane has been associate professor of marine biology and research associate in The Marine Laboratory for the past seven years. After receiving his doctorate from the University of Wisconsin he taught at Stanford University and the University of Wichita. During World War II he served as an aviation physiologist in the Air Force. After his return to civilian life he was coordinator of research and development related to Vitamin A and consultant to the Shark Industries Division of the Borden Company. His present interests include general invertebrate physiology and biochemistry, general biology of marine borers, deep-sea sailing and ocean racing.

DONALD DE SYLVA

Mr. de Sylva attended Northwestern University. He took his Bachelor's Degree at Cornell and his Master's at the University of Miami, with advanced study at the University of California. He was an aquatic biologist with the New York State Conservation Department and research assistant in oceanography at Cornell University on Navy projects. He taught biometry and statistics at the University of California and is now at the Marine Laboratory, University of Miami.

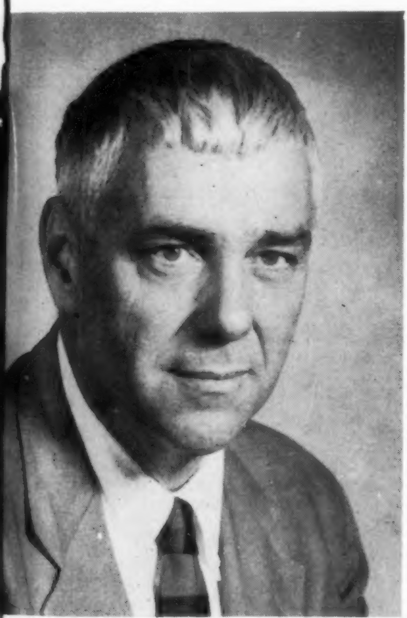
Mr. de Sylva has worked on striped bass, bait shrimp, tunas, mullet, marlin, barracuda and is interested in the systematics, life history and ecology of Western Atlantic and Caribbean fishes, particularly the game fishes.

He served with the U.S. Army in Korea.

FRANCIS B. TAYLOR

Mr. Taylor is a native of Hempstead, New York, born of South Carolina paternal parentage. He is 46 years old and a former newspaper man. He was state news editor and roving reporter for *The News and Courier* of Charleston, S.C., and is now supervisor of sales of Mullins, S.C. tobacco market, public relations consultant to Mullins Chamber of Commerce and a free lance writer. He resides at Mt. Pleasant, S.C. He is married and has four children ranging from one month to 12 years of age.

During World War II he served three and one-half years in the U.S. Coast Guard, enlisting as coxswain. He then went on inactive duty as lieutenant (jg) after service in Atlantic and Pacific Oceans, including duty as commanding officer, executive officer and navigator of several types of craft, from converted yachts on anti-submarine patrol in early war days to sea-going Army tug in Philippine and Okinawan waters.



EDWIN H. MAIRS

Mr. Mairs was born in Albany, N.Y. He attended Loomis School, Harvard College and the Westlawn School of Yacht Design. He has been in and around boats for over thirty-five years and is an enthusiastic sailor. He worked as heating and air conditioning engineer before World War II. Mr. Mairs enlisted in the Naval Reserve in January, 1942, and was placed on inactive duty as Lt. (j.g.) January, 1946, after service on anti-submarine vessels.

He entered full time practice as a naval architect seven years ago and has since had wide experience in the design, construction and surveying of pleasure and commercial small craft. He conducted a survey of the design of southern shrimp vessels and gear in the summer of 1955 for the First Research Corporation of Florida, who are under contract to the U.S. Fish & Wildlife Service.

Looking Ahead

THE BULLETIN is mailed without obligation to those who are interested in the oceans and in the progress of scientific research concerning it.

It is hoped that, with the growing interest and advice of members and others who receive the Bulletin, it will be possible in the future greatly to expand and develop it and eventually to include articles in nontechnical language from all parts of the world, fully illustrated in color. In order to do this, the editors welcome advice and criticism, as well as articles suitable for publication.

Since the Foundation is a nonprofit organization it is necessary to support the cost of publication by extending the active membership. It is hoped that those who are interested in the objectives of the Foundation and who enjoy the Bulletin will give their support to this by bringing it to the attention of their friends and by becoming members themselves.

According to a ruling of the U. S. Treasury Department donations made to the Foundation are deductible in computing taxable income as provided for by the 1954 code.

ACKNOWLEDGMENTS

THE FRONT COVER shows the Danish Training Ship *Danmark*, photographed by Charles E. Lane.

The Back Cover shows how sailfishing is possible even from a small boat. Photograph by West Palm Beach Fishing Club.

Inside front cover, Jerry Greenberg; Pages 2, 4, 5, 6, 30, 40, 46, 49, 50 and 52, The Marine Laboratory, University of Miami; Page 8, Instituto de Oceanografia, Sao Paulo; Pages 9, 10, 12, 13, 14, the Swedish American Line; Pages 17, 18, 20, Bears Bluff Laboratories; Pages 21, 22, 24, 25, 26, 28, 29, West Palm Beach Fishing Club; Pages 32, 33, 34, 35, 36, John Ashton (Curious Creatures in Zoology, 1890) from various sources; Pages 37, 38, 42, 44, 45, 58, U.S. Fish and Wildlife Service; Pages 54, 56, *Southern Fisherman;* Pages 55, 57, First Research Corporation.

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